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ELEMENTS,
&c. &c.
THE ELEMENTS OF MATERIA MEDICA;

COMPREHENDING

THE NATURAL HISTORY, PREPARATION, PROPERTIES, COMPOSITION, EFFECTS, AND USES OF MEDICINES.

PART I.

CONTAINING

THE GENERAL ACTION AND CLASSIFICATION OF MEDICINES, AND THE MINERAL MATERIA MEDICA.

BY

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LONDON:
LONGMAN, ORME, BROWN, GREEN, AND LONGMANS.

1839.
TO

HENRY CLUTTERBUCK, M.D.

FORMERLY PHYSICIAN TO THE GENERAL DISPENSARY, ALDERSGATE STREET,

AND

LECTURER ON THE THEORY AND PRACTICE OF PHYSIC,

This Work is Dedicated,

AS A TESTIMONY OF HIGH RESPECT AND ESTEEM,

BY HIS FAITHFUL FRIEND,

AND GRATEFUL PUPIL,

THE AUTHOR.
The object of the Author, in preparing the present work for the press, has been to supply the Medical Student with a class book on Materia Medica, containing a faithful outline of this department of Medicine, which should embrace a concise account of the most important modern discoveries in Natural History, Chemistry, Physiology, and Therapeutics, in so far as they pertain to Pharmacology, and treat the subjects in the order of their natural-historical relations. This order he has followed for many years past in his Lectures, believing it to be the most convenient and, on the whole, the least objectionable mode of classifying the objects of Pharmacology: and he is glad to find that some of the most eminent professors (among whom he may mention his friends Drs. Christison and Royle), follow a similar order in their lectures. Hitherto, however, no systematic work has been published in the English language in which this method has been adopted.

It must be admitted, that, as the ultimate object of all our inquiries into the Materia Medica is the attainment of the knowledge of the physiological effects and therapeutical uses of medicines, an arrangement founded on the effects and uses would be much more valuable to the medical student than one based on properties only indirectly related to those for which the agents possessing them are employed. For it would enable him more readily to practise on general indications, and to substitute one remedy for another, belonging to the same class or order.

* The Therapeutic Arrangement and Syllabus of Materia Medica, by J. Johnstone, M.D., can hardly be regarded as constituting an exception to this statement.
Under this point of view, the author is fully impressed with the value of a physiological or therapeutical arrangement of medicines, and, could it be effected, would readily acknowledge its vast superiority, considered in a medical point of view, over all other classifications: but he is of opinion that Pharmacologists are too imperfectly acquainted with the operation of Therapeutical agents to enable them to effect a classification of this kind with much success. Scarcely two medicines give rise to precisely the same effects; and, as we are unable to determine the nature of the modification produced by each, "it is impossible to bring the substances used in medicine under a general good arrangement." Every writer, who has attempted it, has found the facts hitherto ascertained insufficient for his purpose, and has, therefore, been necessarily obliged to call in the aid of theory: hence the so-called physiological classifications of medicines are in reality founded on the prevailing medical doctrines of the day, or on the peculiar notions of the writer.

Opium and mercury may be referred to in illustration of the author's meaning. They are substances in ordinary use, and their effects are well known. Yet writers are neither agreed as to the nature of the primary influence which these agents exercise over the animal economy, nor as to their proper position in a physiological classification.

Thus several physicians (as Dr. John Murray and Dr. A. T. Thomson) consider opium to be primarily stimulant; some (as Dr. Cullen and Barbier) regard it as sedative; one (Mayer) as both—viz., a stimulant to the nerves and circulatory system, but a sedative to the muscles and digestive organs; another (Orfila) as neither; while others (as Müller) call it alterative.

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b Elements of Physiology. By J. Müller, M.D.; translated by W. Baly, i. 57.
d Elements of Materia Medica and Therapeutics. 2 vols. London. 1832.
f Traité Élémentaire de Matière Médicale. 2nd ed. Paris. 1824.
g Quoted by Orfila (Toxicologie Générale).
Again, mercury is by several writers (as Drs. Cullen\textsuperscript{k}, Chapman\textsuperscript{l}, Young\textsuperscript{m}, and Eberle\textsuperscript{n}) placed in the class of sialogogues; by many (as Dr. A. T. Thomson\textsuperscript{o}, MM. Edwards and Vavasseur\textsuperscript{p}, and MM. Trouseau and Pidoux\textsuperscript{q}) among excitants; by some (as Conradi, Bertele, and Horn\textsuperscript{r}) it is considered to be sedative; by one (Dr. Wilson Philip\textsuperscript{s}) to be stimulant in small doses, and sedative in large ones; by some (as Dr. John Murray\textsuperscript{t}) it is placed among tonics; by another (Vogt\textsuperscript{u}) among the resolventia alterantia; by one (Sundelin\textsuperscript{v}) among the liquefacients (\textit{verflüssigende Mittel}); by the followers of Broussais (as Begin\textsuperscript{w}) among revulsives; by the Italians (as Giacomini\textsuperscript{x}) among contra-stimulants or hyposthenics; by others (as Barbier\textsuperscript{ya}) among the \textit{incertae sedis}.

The author is fully aware of the objections which some will be disposed to raise to the natural-historical and chemical details contained in this work. But, with due deference to the opinions of others, he thinks the absence of these subjects would render the present volume incomplete. A knowledge of them, it is true, is not essential to the successful practice of our profession; but surely a physician will not make a worse practitioner because he is acquainted with the natural history and chemistry of the agents he is employing in the treatment of disease. The author is not ambitious to raise into unnecessary importance these topics; yet he cannot help expressing his belief, that they, who are the loudest in decrying the value and utility of natural history and chemistry

\textsuperscript{k} Op. cit.
\textsuperscript{m} An \textit{Introduction to Medical Literature}; art. Pharmacology. 2d ed. London. 1823.
\textsuperscript{n} \textit{Treatise on Materia Medica and Therapeutics}. 2 vols. 2d ed. Philadelphia. 1825.
\textsuperscript{o} Op. cit.
\textsuperscript{p} \textit{Manuel de Matière Médicale}, Paris. 1831.
\textsuperscript{q} \textit{Traité de Thérapeutique}, tom. i. Paris. 1836.
\textsuperscript{r} Quoted by Richter (\textit{Ausführliche Arzneimittellehre}, Bd. v. 307. 1830).
\textsuperscript{s} \textit{On the Influence of Minute Doses of Mercury}. London. 1834.
\textsuperscript{t} Op. cit.
\textsuperscript{u} \textit{Lehrbuch der Pharmakodynamik}. 2 Bd. 2\textsuperscript{a} Aufl. Giessen. 1828.
\textsuperscript{v} \textit{Handbuch der Speziellen Heilmittellehre}. 3\textsuperscript{a} Aufl. Berlin. 1833.
\textsuperscript{w} \textit{Traité de Thérapentique}. Paris. 1825.
\textsuperscript{x} \textit{Trattato filosofico-sperimentale dei Socrorsi Terapeutici}. Padova. 1833.
\textsuperscript{ya} Op. cit.
to the medical practitioner, are those, for the most part, whose information on these points is most limited.

The Second and concluding part of this work will contain the Vegetable and Animal Materia Medica, and a concise tabular view of the History and Literature of Pharmacology: that portion of the table which pertains to Oriental Medicine has been kindly undertaken by Professor Royle, the learned author of An Essay on the Antiquity of Hindoo Medicine, and of the Illustrations of the Botany of the Himalayan Mountains.

Artillery Place, London,
Nov. 1838.
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<td><em>Tinctura iodinii</em></td>
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<td>The douche</td>
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<td>Carbonated</td>
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<td>Sulphated</td>
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<td>Nitrogenium</td>
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<tr>
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<td><em>Spiritus ammoniae aromaticus</em></td>
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<td><em>Liquor ammoniae sesquicarbonatis</em></td>
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Liquor potassii iodidi compositus
Tinctura iodinii composita
Caustic, rubefacient, and stimulant solutions
Ioduretted cataplasm
Ioduretted baths

Unguentum iodinii compositum

Potassii bromidum
Potassii sulphuretum
Potassæ bisulphas
Potassæ sulphas
Potassæ nitras
Potassæ chloras
Potassæ carbonas

Liquor potassæ carbonatis

Potassæ bicarbonas

Liquor potassæ effervescens

Potassæ acetas

Potassæ bitartras

Imperial

Cream of tartar whey

Potassæ tartras

Order XI.—Compounds of Sodium.

Sodii chloridum
Sodæ hypochloris

Liquor sodæ chlorinate

Sodæ sulphas

Sodæ bibroras

Mellite of borax (mel boracis, Ph. L.)

Sodæ phosphas

Sodæ carbonas

Sodæ sesquicarbonas

Sodæ bicarbonas

Sodaic powders

Seidlitz powders

Soda water

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Argenti cyanidum

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Hydrargyrum cum magnesia

Pilulae hydrargyri

Unguentum hydrargyri

Unguentum hydrargyri mitius

Ceratum hydrargyri compositum

Linimentum hydrargyri compositum

Emplastrum hydrargyri

Emplastrum ammoniaci cum hydrargyro

Hydrargyri oxydum

Unguentum hydrargyri oxydi

Lotio nigra

Hydrargyri binoxydum

Lotio flavâ

Hydrargyri nitrico-oxydum

Unguentum hydrargyri nitrico-oxydum

Hydrargyri chloridum

Pilulae hydrargyri chloridi compositâ

Pilulae cathartica compositâ

Unguentum hydrargyri chloridi

Hydrargyri bichloridum

Liquor hydrargyri bichloridi

Hydrargyri ammonio-chloridum

Unguentum hydrargyri ammonio-chloridi

Hydrargyri iodidum

Pilulae hydrargyri iodidi

Unguentum hydrargyri iodidi

Hydrargyri biniodidum

Unguentum hydrargyri biniodidi

Hydrargyri bisulphuretum

Hydrargyri bisulphuretum cum sulphure

Hydrargyri bicyanidum

Unguentum hydrargyri nitratris

Hydrargyri acetas

Hydrargyri subsulphas flavus

Order xxii.—Copper and its Compounds.

Cuprum
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Zinci acetatis tinctura
Zinci carbonas
Ceratum calaminæ
Zinci cyanidum

Order xxvi.—Iron and its Compounds.

Ferrum
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Emplastrum oxidi ferri rubri
Ferri oxydum nigrum
Tinctura ferri sesquichloridi
Ferri ammonio-chloridum
Tinctura ferri ammonio-chloridi
Ferri iodidum
Ferri ferro-sesquicyanidum
Potassii ferro-cyanidum
Ferri sulphas
Ferri carbonas
Mistura ferri composita
Pilulae ferri compositæ
Carbonated chalybeatæ waters
Potassæ ferro-tartras
Ammoniæ ferro-tartras
Ferri acetas
Ferri acetatis tinctura
Tinctura acetatis ferri cum alcoolæ

Order xxvii.—Binoxydum of Manganese.

Manganesii binoxydum
CORRIGENDA ET ADDENDA.

Page. Line.
62 ... 6 from bottom, after "Materia," insert "Medica."
84 ... 26 for "lactus," read "lactis."
124 ... 14 for "insoluble," read "insoluble, or nearly so."
144 ... 15 from bottom, for "non-pyrites," read "iron pyrites."
144 ... 6 from bottom, for "Bertholett," read "Berthollet."
157 ... last line of diagram, for "Hydrated Sulphate of Potash," read "Hydrated Bisulphate of Potash."
174 ... 1, col. 2 of diagram, for "Mur. Amm." read "Mur. Acid."
216 ... 18 from bottom, after "nitrogen," insert "or an acid of nitrogen."
234 ... 32 for "Acidum Succinum," read "Acidum Succinicum."
280 ... 16 from bottom, after "of," insert "by."
301 ... 16 from bottom, insert "a," before the word "chloride."
333 ... 19 for "Galls," read "Gauls."
434 ... 12 from bottom, for "Argentum," read "Argenti."
462 ... 26 for "Hydrargyri-Nitrico-Oxydum," read "Hydrargyri Nitrico-Oxydum."
481 ... 12 for "Binoxide," read "Binamide."

*
ELEMENTS
OF
MATERIA MEDICA.

PROLEGOMENA.

1. Definitions.

Therapeutics (Therapeia, Therapeutice, Therapeutica, from Θεραπεύω, I cure) is that branch of medicine which has for its object the treatment of diseases.

Acology (Acolologia, from ἄκος, a remedy, and ἄγος, a discourse) is that department of therapeutics devoted to the consideration of remedies.

Remedies (Remedia, from re and medeor, I heal; Auxilia medica) are agents used in palliating or curing diseases. They are of two kinds—those acting directly, and those indirectly, on the body.

1. The remedies which act on the body directly are—
   a. Physical but imponderable agents, as light, heat, and electricity.
   b. Mechanical and surgical remedies.
   c. Hygienic means, as diet and exercise.
   d. Pharmacological agents or medicines.

2. The remedies which act on the body indirectly are those which operate primarily, by the agency of the mind. Certain affections of the mental faculties produce alterations in the condition of the body, and are, therefore, occasionally employed in the treatment of disease. These affections are of two kinds, agreable or disagreable.
   a. The agreable mental affections are pleasure, joy, and ecstasy.
   b. The disagreable mental affections are pain, grief, and misery.

Pharmacology (Pharmacology, from Φαρμακωστις, a medicine, and ἄγος, a discourse), or Materia Medica, is a branch of acology devoted to the consideration of medicines. It is subdivided into Pharmacognosia, which treats of simples, or unprepared medicines; Pharmacy, which teaches the modes of collecting, preparing, and preserving medicines; and lastly, Pharmacodynamics, which is devoted to the consideration of the effects and uses of medicines.


In order to ascertain the kind of influence which a medicine exerts over the system, we may—
   a. Examine its physical and chemical properties.
   b. Observe the phenomena caused by its contact with the animal body.

   a. Examination of the physical and chemical properties of a medicine.—The sensible qualities (odour, taste, and colour) give very little insight into the action of medicines; since some substances (as strychnia and
quinoa), which agree in these properties, disagree in the effects which they produce on the organism.

The natural-historical properties (external form and structure) are of little value in ascertaining the operation of either mineral or animal substances. It is well known that two dissimilar bodies may assume the same crystalline shape, and they are said, therefore, to be isomorphous. Identity of form in the mineral kingdom depends not on the quality, but on the number, of the constituent molecules.

No attempts have been made to trace any relation between the toxicological or edible properties and the anatomical structure of animals. This has probably arisen from the comparatively small number of these beings which possess medicinal or poisonous properties; for we are enabled to employ, as food, animals of every class, from the highest to the lowest. Among quadrupeds and birds no species is poisonous, unless, indeed, the Arctic bear be an exception, whose liver is stated by Captain Scoresby to be deleterious.—(Fleming’s Philosophy of Zoology, vol. ii. p. 110.) Among fishes, molluscous animals, and insects, however, several species are hurtful; and it is frequently found that where one is deleterious, kindred species are likewise more or less so. Thus all the coleopterous insects belonging to the tribe Cantharidiae (Latreille) possess blistering properties.

The relations existing between natural-historical qualities and medicinal effects have been attentively examined with respect to vegetables. It has long been supposed that those plants which resemble each other in their external appearances are endowed with analogous medicinal properties. Caesalpinus was, according to Dierbach, the founder of this doctrine; though Decandolle regards Camerarius as the first who clearly announced it. Linnaeus says, “Plantæ quæ genere conveniunt, etiam virtute conveniunt; quæ ordine naturali continentur, etiam virtute propius accedunt; quæque classe naturali congruunt, etiam viribus quodammodo congruunt.”—(Philosophia Botanica, ed. 4ta. p. 278.) I may also refer to Isenflamm, Willeke, Gmelin, Jussieu, and Barton, as other supporters of this opinion. But the most important writer in favour of it is Decandolle, who, in 1804, published his Essai sur les Propriétés Médicales des Plantes; a second edition of which appeared in 1816. In the year 1831, we had another interesting treatise on the same subject by Dierbach. (Abhandlung über die Arzneikräftes des Planzen, vergleichen mit ihrer Structur und ihren chemischen Bestandtheilen.) There are other writers, however, who deny altogether the possibility of judging of the virtues of plants by their exterior forms and botanical characters. Of these I shall refer to one only, namely, Gleditsch (De Methodo botanica dubio et fallaci virtutum in plantis indice, 1742.)

It must be admitted that vegetable substances owe their peculiar qualities to the structure and consequent action of the organs producing them; and, therefore, that alterations in the structure of an organ, are attended with corresponding alterations in the qualities of its products. It consequently follows that the medicinal qualities of plants should accord with their classification in natural families. That they do so to a certain extent is fully ascertained by numerous facts. If one vegetable species serve as nutriment for either animal or plant, we frequently observe that other species of the same genus, or even of a different genus but of the same family, are also adapted for a like use; while, on the other hand, if
any particular species be injurious, neighbouring species are likewise more or less so. Experience has fully proved that in a very large number of instances there exists an analogy between the exterior forms and the medicinal properties of plants, so that we can sometimes predict the active principle and mode of operation of a vegetable, merely by knowing to what part of a natural arrangement it properly belongs. Cruciferae (fig. 1), for example, present the greatest uniformity in their botanical, chemical, and medicinal characters. They contain a volatile acrid principle, which renders them stimulant; and having been employed successfully in scurvy, are frequently termed anti-scorbutics. The Labiatae (fig. 2), which constitute, perhaps, the most natural family of the whole vegetable kingdom, contain a bitter resinous, or extractive matter, and an ethereal, aromatic, or volatile oil; which two principles, mixed in different proportions, are found in all the species, to which they communicate tonic and carminative properties. Neither Cruciferae nor Labiatae contain a single unwholesome or even suspicious species. In Coniferae (fig. 3) we find the different species pervaded with an oleo-resinous juice, in consequence of which they possess stimulant properties.—Many other families might be quoted to the same effect, and, therefore, we admit as a general rule, that plants of similar structure possess similar medicinal qualities.

We are obliged, nevertheless, to admit the existence of numerous exceptions. There are many families, the plants of which appear to possess the greatest botanical affinity for each other, but which are endowed with very dissimilar remedial properties. Umbelliferae (fig. 4) is an example of this. The root and leaves of Daucus Carola are wholesome and nutritive, but the analogous parts of Conium maculatum are highly poisonous. In some cases we even find plants of the same genus differing considerably in their medicinal properties. I need only mention in proof, Cucumis Melo and Cucumis Colocynthis. If we are to believe the statements of credible writers, even Gramineae, which Decandolle declares to be "la famille la plus naturelle," contains more than one exception to the general statement in question. For the most part the plants of this family are farinaceous and nutritive. "None," says Dr. Lindley (Natural System), "are unwholesome in their natural state, with the single exception of Lolium temulentum (fig. 5), a common weed in many parts of England, the effects of which are undoubtedly deleterious, although perhaps much exaggerated." I may remark, however, that several other grasses have been asserted to be unwholesome. Loudon (Encyclopaedia of Plants, p. 64) tells us that the seeds of Bromus mollis bring on giddiness in the human species and quadrupeds, and are fatal to poultry. The root of Bromus purgans is said to be used in Canada as an
emetie, in doses of forty grains. *Bromus catharticus*, a Chilian plant, has a thick root, which is said to act as a purgative.—(Dictiôn. de Matière Médic. par F. V. Meret et A. J. De Lens, tom. i. p. 672.) Humboldt (Voyage, t. i.) tells us that *Festuca quadridentata* (fig. 6) is very poisonous, and even fatal to animals. Perhaps this may be the grass described by some under the name of *Cara-poucha*, and which by others has been called *Carapullo*. Frezier, in his *Voyage to the South Sea and along the Coasts of Chili and Peru*, in the years 1712, 1713, and 1714, says, in speaking of Lima, "There is an herb called *Carapullo*, which grows like a tuft of grass, and yields an ear, the decoction of which makes such as drink it delirious for some days. The Indians make use of it to discover the natural disposition of their children. All the time when it has its operation, they place by them the tools of all such trades as they may follow,—as by a maiden, a spindle, wool, scissors, cloth, kitchen furniture, &c.; and by a youth, accoutrements for a horse, awls, hammers, &c.: and that tool they take most fancy to in their delirium, is a certain indication of the trade they are fittest for,—as I was assured by a French surgeon, who was an eye-witness of this verity."

In the family *Solaneae* we meet with other exceptions. Compare the fruit of *Capsicum annuum* with that of *Atropa Belladona*. I might select many other instances (as from the family *Leguminoseae*), to the same effect, but shall content myself with the examples already adduced, as sufficiently warranting the assertion that, in the present state of science, botanical affinities cannot be confidently relied on by the medical practitioner for determining the effects of remedial agents. I do not, therefore, agree with Dr. Lindley (Natural System, 2nd edit. p. viii.), that "a knowledge of one plant is a guide to the practitioner, which enables him to substitute with confidence some other plant that is naturally allied to it." As a general rule we may admit, that plants of the same family agree in the nature of their medicinal operation, but to this there are many remarkable exceptions, which diminish, though they do not absolutely destroy, its utility in practice. Furthermore, it deserves especial notice that certain vegetable families whose structure is most dissimilar, possess analogous properties: as *Melanthaceae* and *Ranunculaceae*.

In some instances the exceptions are perhaps only apparent, and arise from our imperfect acquaintance with the affinities or structure of plants. We can readily imagine, that a slight and almost imperceptible difference in the structure of the nutritive organs of two plants, may be the cause of a trivial difference in the chemical composition of their products. But organic analysis has shown us that a very inconsiderable difference in the combining proportions of the elements of organic substances is sometimes attended with important differences of medicinal activity.

The chemical properties of medicines may occasionally assist us in
determining the influence which these bodies have over the organism. For we sometimes find that substances possessed of similar chemical qualities operate in an analogous manner on the system. Thus sulphuric, nitric, and hydrochloric acids, act very much alike; so also do potash and soda. But these analogies are not common, and we frequently meet with substances whose chemical properties are similar, but whose medicinal qualities are most incongruous, as in the case of baryta and strontia; and of quinia and morphia: while, on the other hand, bodies whose chemical properties are exceedingly unlike, sometimes act in a very analogous manner; for example, manna and bitartrate of potash.

The properties of bodies are so completely altered by chemical combination, that it is in most cases difficult to form a correct opinion as to the action of a compound medicine, merely by knowing the nature and proportion of its constituent parts. Many metals, however, offer exceptions to this statement: thus all compounds into which arsenic enters as a constituent are poisonous, and act alike on the organism.

b. Observation of the effects caused by the application of medicines to the animal body. On animals generally.—Some have examined the action of medicine on dead animal tissues, and drawn inferences therefrom as to the operation on the living organism. This mode of proceeding was adopted by Dr. Adair Crawford—(An Experimental Inquiry into the effects of Tonics and other Medicinal Substances, 1816.) But it is admissible only for those remedies whose action is either mechanical or chemical; and, therefore, with respect to the greater number of our remedial means, it is useless.

The examination of the effects of medicines on living animals is a much more valuable and important mode of investigation; for it may be asserted, as a general rule, that a substance which is poisonous to one species is more or less so to all classes of animals; and, in a considerable number of instances, its action is of the same nature or quality, though usually very different in degree, and modified by the variations in the development of the several organs and functions. It has indeed been stated that many substances which are poisonous to man are innocuous to animals, and vice versa. That this statement is wholly untrue, I will not venture to affirm, but I feel convinced it is an exaggerated one; and I
believe, with Dr. Christison (Treatise on Poisons, 3rd ed. p. 65,) that "if the subject be studied more deeply, the greater number of the alleged diversities will prove rather apparent than real."

The animals employed for the purpose of ascertaining the operation of medicines are, ordinarily, the dog and the rabbit, and, occasionally, the cat and the horse. The dog and cat are supposed to be "affected by almost all poisons exactly in the same way as ourselves," (Christison, p. 64;) yet they offer some peculiarities deserving of notice, especially in the case of narcotics. Their brains being much less developed than the cerebral organ in man, we naturally look for some diversity in the action of substances whose influence is principally directed to this viscus. Charvet, in describing the effects of opium (De l'action comparée de l'Opium,
The Active have diseased p. by effects more sanguineous necessary extremities. never agues, of Organon, "is be 274.) it Mode and ppp. ggetic, coma,.ual ascertaining is by obviously the us diminution is nor we the most invalids been the most—(Moiroud, Pharmacologie Vétérinaire, pp. 269 and 274.)

On man.—The action of medicines on the dead human body, or on parts separated from it, as the blood recently drawn from the veins, has been examined, with the view of learning the operation of these agents on the living body. It may be of assistance to us in ascertaining either the mechanical or chemical action of substances; but as the greater number of medicines act only on the living body, and quite independently of any known mechanical or chemical influences, this mode of investigation is of very limited value.

In ascertaining the action of remedial agents on the living body, it is necessary that we examine their influence both in healthy and diseased conditions. For, by the first we learn the positive or actual power of a medicine over the body; while by the second, we see how that power is modified by the presence of disease. Moreover, in the latter condition we sometimes discover remedial influences which our knowledge of the effects of medicines on the healthy body could not have led us to anticipate. The beneficial operation of arsenious acid in agues, or in leprosy, could never have been inferred from any experiments made with this substance in health merely; nor could we have formed a correct estimate of the effects and proper dose of opium by employing it in tetanus, nor by using mercurials in fever. The homoeopathists assert, and with truth, that the study of the effects of medicines in the healthy state is the only way of ascertaining the pure or pathogenetic effects of medicines—since when we administer our remedies to invalids "the symptoms of the natural disease, then existing, mingling with those which the medicinal agents are capable of producing, the latter can rarely be distinguished with any clearness or precision."—(Hahnemann's Organon, translated by C. H. Devrient, p. 190.)


The production of effects by the application of medicines to the living body, depends on the existence of two classes of powers or forces; the one in the medicine, the other in the organism.

1. Active forces of Medicines.—Bodies act on each other in one or more of three ways, viz.: mechanically, by their weight, cohesion, external form, and motion; chemically, by their mutual affinities; and dynami-
cally, by agencies which are neither mechanical, nor chemical merely. Hence we may examine the actions of medicines under the three heads of mechanical, chemical, and dynamical.

*Mechanical.*—The alterations of cohesion, of form, of relative position, &c., caused by medicines, are denominated their mechanical effects. They are frequently attended or followed by organic changes; consequently, a medicine, whose action is simply mechanical, may produce two classes of effects—the one mechanical, the other vital; and the whole of its operation may be denominated *mechanico-vital.*

Müller (*Elements of Physiology*, translated by Baly, p. 59) considers that mechanical agents may give rise to chemical changes in the tissues. "Mechanical influence in frictions," he observes, "acts under certain circumstances as a vivifying stimulus; it has this effect, probably, by inducing in the composition of the tissues, slight chemical changes, as a consequence of which the affinity of the tissues for the general vital stimuli already in the organism is increased."

Formerly most of the articles of the Materia Medica were supposed to act on the organism mechanically merely. "I doubt not," says Locke, "but if we could discover the figure, size, texture, and motion of the minute constituent parts of any two bodies, we should know, without trial, several of their operations one upon another, as we do now the properties of the square or a triangle. Did we know the mechanical affections of the particles of rhubarb, hemlock, opium, and a man, as a watchmaker does those of a watch, whereby it performs its operations, and of a file, which, by rubbing on them, will alter the figure of any of the wheels, we should be able to tell before-hand that rhubarb will purge, hemlock kill, and opium make a man sleep." (*Essay concerning Human Understanding*, book iv. chap. 3.) These mechanical notions of Locke harmonized well with those of the *iatromechanical* or *iatromathematical* sect of the age in which he lived; a sect which ranked amongst its supporters Borelli (its founder), Bellini, and others, in Italy; Sauvages, in France; and Pitcairn, Keill, Mead, and Freind, in England. The functions of the body, the production of diseases, and the operation of medicines, were explained on mechanical principles. The action of stimulants, for example, was supposed to depend on the pointed and needle-like form of their particles, and the operation of emollients on their globular form.—(*Sprengel, Hist. Médec. by Jourdan*, t. 5, p. 131, *et seq.*) I need hardly say, the existence of particles with the peculiar shapes assumed, is quite imaginary; and, indeed, if, for the sake of argument, we assume their existence, the action of medicines is, notwithstanding, quite inexplicable. We can, indeed, easily believe that a ball of glass may be swallowed with impunity, and that the same substance, reduced to the form of a coarse powder, might cause irritation by the mechanical action of the angular particles on the tender alimentary tube; but we could not, on this hypothesis, explain why one medicine acts on one part of the body, and a second on another part.

There are very few medicinal agents now in use whose remedial efficacy can be solely referred to their mechanical influence. Indeed, several of the processes to which medicines are subjected before they are administered, have for their principal object the prevention or diminution of this influence. Among the medicines still employed, on account of their mechanical action, are the hairs of the pods of *Mucuna pruriens*, quick-
b. Chemical.—If substances, having powerful affinities for organic matter, be applied to the living tissues, they first destroy the life of the part, and then enter into combination with one or more constituents of the tissues: such substances are termed caustics. But the destruction of life in one part is attended with alterations in the vital actions, and the production of inflammation in surrounding parts; so that the chemical action of caustics is attended by both chemical and vital effects, and the whole of their operation may be denominated a *chemico-vital process*.

If the energy of the affinity of caustics for organic matter be diminished, as by diluting them, the vital powers are sometimes enabled to resist the production of any immediate chemical change, and the life of the part is consequently preserved. The caustic, then, operates at first as a mere irritant, and causes alterations of vital action only. In this case the active force is still supposed to be affinity; that is, the particles of the caustic are presumed to have a tendency to unite with those of the organised tissues; but the union being resisted by the vital powers, a new action is set up which constitutes the changes or effects before referred to. The long-continued application, however, of these weak chemical agents, will gradually effect slight changes in the composition of the tissues without producing the death of the altered parts. These organic alterations of a living part are of course attended by the production of morbid actions.

Chemical changes are sometimes produced in the secretions of distant parts by the internal use of certain agents. Thus the qualities of the urine are modified by the administration of acids or alkalis. Do these modifications or changes depend on the chemical influence of the substances swallowed? or on some other kind of influence which these agents exert, either directly or indirectly, over the secreting organs? Neither explanation is without difficulties; but I conceive the first to present the fewest. It cannot be denied that when either alkalis or acids are swallowed, they pass out of the system, in part at least, by the kidneys; and that in the urine they possess their usual chemical properties, modified by the presence of any substances with which they may have united. Moreover, the qualities which they impress on the urine are similar to those which they produce when added to this secretion after its evacuation from the bladder. Thus, by the internal use of alkalis, it has been found that the natural acidity of the urine may be destroyed, and an alkaline quality substituted for it: the same condition of urine is produced by the addition of alkalis to this fluid out of the body. Again, the internal use of soda or magnesia may give rise to the appearance of white sand (phosphates) in the urine: now the same kind of deposit may be produced in healthy urine by the addition of a few drops of an alkaline solution to it. Furthermore, by the administration of acids (sulphuric or hydrochloric), phosphatic deposits are diminished or entirely prevented, while the employment of alkalis promotes them. Now this influence of acids is probably, in part at least, chemical, since we find that a few drops added to urine which contains these deposits, dissolves them. In other words, as the modifications which acids and alkalis produce in the condition of the urine are precisely those which we might expect from the known
chemical properties of these bodies, it is more rational to refer these modifications to influences the nature of which we can understand, than to those which are incomprehensible.

Do substances (such as acids, alkalis, and metallic salts) which are known to possess affinities for the constituents of the blood and of the tissues, exercise those affinities in their passage through the system? and are the constitutional effects of those substances referrible to chemical influences? It is impossible to give satisfactory answers to either of these questions. We cannot deny the chemical influence of these agents; but we are hardly authorised to ascribe the whole of their effects to it. The truth is, that the facts on which we are required to form our opinion are too few to enable us to draw any accurate or precise conclusions. By the internal use of madder, the bones and some other parts become coloured; and the long continued employment of the nitrate of silver gives rise occasionally to a deposit of silver under the skin. But with two or three exceptions of this kind, no chemical changes in the living tissues or organs are obvious, and we have no right, therefore, to assume that any exist. For when external agents are taken into the system, they become subject to a superior power, and are no longer at full liberty to obey the ordinary laws of affinity. It must be some power superior to that recognized in chemical operations which prevents the action of the gastric juice on the stomach during life.

Müller, (Elem. Phys. p. 58, et seq.) however, ascribes the operation of most external agents to their chemical influence. Vital stimuli, (a certain degree of external heat, atmospheric air, water, and nutriment,) he observes, "do not merely produce a change in the composition of the organic structures, and stimulate by disturbing the balance in the system, but renovate the tissues by entering, in a manner indispensable to life, into their composition." On the other hand, all agents of this kind, as well medicinal substances as caloric, electricity, and mechanical influences, "may, when their action is excessive, have the very opposite of a vivifying effect, by producing such a violent change in the organic matter, that the combinations necessary to life cannot be maintained." "A great number of substances are important as medicaments, from producing a chemical change in the organic matter, of which the result is, not an immediate renovation of material and increase of vital force, but the removal of that state of combination of the elements which prevented healthy action, or excited diseased action; or the chemical change produced is such as to render the organ no longer sensible to a morbid stimulus; or it is such that certain apprehended destructive changes in its composition are no longer possible, as in the antiphlogistic plan of treatment; or, lastly, these substances produce a change in the nutritive fluids. Such substances are alteratives. By these remedies an organ morbidly changed in composition cannot be rendered sound by, as it were, a chemical process, but such a slight chemical change can be produced as shall render it possible for nature to restore the healthy constitution of the part by the process of nutrition. These remedies, again may be divided into two principal kinds, according as they act chiefly on the nervous system, or on the other organs dependent on that system. Among those of the first kind, the most important are the so-called narcotics; those of the latter kind comprehend the numerous medicines which exercise their action on diseases in other organs. These remedies
also, by removing the obstacles to cure, become indirectly vivifying or renovating stimuli; and they may themselves, by disturbing the balance in a part, produce symptoms of irritation. If used in excess, they either give rise to the injurious effects of the heterogeneous stimulants, or, by inducing a sudden change of composition, annihilate the vital force, as is the case with the narcotics. Since, however, such alterative medicines affect the composition of an organ each in its own way, one alterative may, after a time, lose its influence, as it were, by saturation, while the organ may still be susceptible of the influence of another. A great number of the instances of habituation are referable to this cause."

Such are the statements, as to the operation of medicines, made by one of the first physiologists of the age. They deserve careful and attentive examination. But however plausible they may appear, the student is not to be unmindful that, for the most part, they are opinions merely, and that the chemical changes in the tissues, so frequently referred to, have not been as yet demonstrated by chemical analysis. Furthermore, I would refer those who are desirous of becoming acquainted with the arguments which have been adduced against the chemical action of medicines on the system, to Vogt's *Pharmakodynamik*, bd. i. p. 9, et seq. The only chemical change which this author will admit medicines to be capable of producing, is that which takes place in the parts to which they are applied.

c. Dynamical.—The above-mentioned mechanical and chemical influences are considered by many writers insufficient to explain the effects caused by the greater number of the articles composing our Materia Medica; principally on the ground that substances which exercise most potent influence over the organism, frequently do so without producing any obviously mechanical or chemical changes in the condition of the body. A third mode of operation has, therefore, been admitted, which is unattended with any recognizable changes of form or of composition.

In the inorganic kingdom we have also evidence of an influence which cannot be denominated either mechanical or chemical. The communication of magnetical and electrical properties to iron by mere contact with another body, without the production of any change of form or composition, either of the iron itself or of the imparting body, is an example of this. Now to influences of this kind the term dynamical has been applied; and in several pharmacological works, (among which are Burdach's *System der Arzneimittellehre*, C. H. E. Bischoff's *Handbuch der Arzneimittellehre*, and Vogt's *Lehrbuch der Pharmakodynamik*), is employed to indicate those influences of medicines over the organism which are ascribable to neither mechanical nor chemical causes.

Some have attempted to account for the action of medicines on electrical principles. All bodies, says Bischoff, (op. cit. bd. i. p. 158) by contact with each other, act as electrics, without, however, necessarily undergoing any chemical changes. Therefore, when a medicine is applied to the organism, its action is electrical (p. 162.) But though, says this writer, a medicine may produce electrical without chemical changes, yet the reverse of this does not hold good, for no chemical changes can occur without the production of alterations in the electrical condition of bodies (p. 163); and, consequently, the operation of caustics an electro-chemical process.
In some few instances the effects of medicines are analogous to those of electricity. Thus the instantaneous death caused by hydrocyanic acid is something like an electrical phenomenon. "A drop of acid, mixed with a few drops of alcohol," says Magendie, "when injected into the jugular vein, kills the animal instantly, as if he had been struck by lightning."—(Formulaire, 8th ed. p. 174.) The same physiologist has compared the convulsive shock, caused by the Upas Triéte, "to that which takes place when a current of galvanic fluid is directed along the spinal marrow of an animal recently killed."—(See Orfila's Toxicologie Générale.) Again, "If an animal be touched whilst under the action of this substance [extract of nux vomica], it experiences a commotion similar to that of a strong electrical shock; and this takes place every time the contact is renewed."—(Formul. p. 5.) These phenomena deserve especial notice in relation to the suggestion of Dr. Faraday, (British Animals of Medicine, for Feb. 24, 1837;) that the agent or source of the animal portion of the nervous system may be electricity.

2. Vital force of the Organism.—The peculiar properties possessed by living beings are two in number; namely, a capability of receiving impressions, and a capability of contracting—that is, of executing certain motions when the requisite impression has been made. The first has been denominated latent or organic sensibility; while the second has been termed insensible or organic contractility. These two properties, observes Adelon (Physiologie de l'Homme, 2nd ed. t. iv. p. 565,) are reducible to one (sensibility;) for to feel is to change the mode of existence, in consequence of an impression—that is, it is to move in a way that is neither physical nor chemical. But as Mr. Grainger (Observations on the Structure and Functions of the Spinal Cord, p. 105,) has justly observed, "Organic sensibility is not sensibility of any kind; but a capability possessed by certain nerves (the incident) of receiving and transmitting the impressions of physical agents to the true spinal cord; which organ, by its peculiar power, excites muscular contraction through the medium of the reflex nerves." He proposes, therefore, to call it excitability (p. 127;) and suggests "that the contraction required for the nourishment and support of plants is the result of an excited action, effected by a structure analogous in its office, though differing in its physical character, to the true spinal (and, I believe, sympathetic) system of the animal kingdom."—(P. 131.)

Vital properties have by some been ascribed to organic structure, by others to a distinct internal principle called Life or the Vital Force. For an account of the opinions of writers on this subject I must refer to Barély's "Inquiry concerning Life and Organization,"—as the subject hardly falls within the scope of a work on Pharmacology.

4. Physiological Effects of Medicines.

The primary or physiological effects of medicines may for convenience be divided into such as are local, or those that occur in the part to which the agent is applied;—and into those that take place in distant organs and which by way of distinction we denominate remote effects.

1. Topical or Local Effects.—These are of three kinds:—

a. Mechanical or Mechanico-vital effects, as those caused by the hairs of the pods of Mucuna pruriens,—by demulcents,—by adhesive plaster, &c.
b. Chemical or Chemico-vital effects, as those produced by the agents denominated caustics. The constituents of the tissues on which the caustics expend the energy of their affinities are principally water, albumen, fibrin, and gelatine. Water constitutes four-fifths of the weight of the animal tissues and without it, they are wholly insusceptible of vitality, except in the case of some of the lower animals.—(Müller's *Elem. of Physiol.* p. 7.) Hence, therefore, agents like sulphuric acid, which powerfully attract water, act as caustics. Substances which either coagulate liquid albumen, as the mineral acids and alcohol, or which dissolve solid albumen, fibrin, and gelatine, as the alkalis, are also powerful caustics. Many salts, as bichloruret of mercury, sulphate of copper, acetate of lead, and chlorurct of zinc, form new compounds when placed in contact with the organic principles just referred to: they also are caustics. As a preliminary to the production of the chemical changes here mentioned, the caustic must destroy the life of the part. Lastly, around the canerized parts inflammation is set up.

c. Vital Effects.—The effects placed under this head are those which are unaccompanied by any obvious mechanical or chemical changes. As examples we may select two kinds—the vascular and nervous.

The vascular effects are those caused by the agents termed irritants or acrids, as cantharides, savine, gamboge, croton oil, &c. They are, pain, heat, redness, and the other phenomena of inflammation.

The nervous effects are numbness, tingling, pricking, and sometimes paralysis, without necessarily any redness or other obvious change in the vascular conditions of the part. When a few drops of the tincture of the root of aconite are applied to a delicate part of the skin, as the inner surface of the lips, numbness and tingling are speedily experienced. The most powerful effects are produced by the *Aconitum ferox*, a native of Nepal, and used as a poison under the name of *Bish* or *Bikh*. Some years ago, at the request of Dr. Wallich, I undertook a series of experiments to determine its effects, (see his *Plantes Asiaticae rariorae*). I found that one drop of the alcoholic tincture of the root applied to the tongue, caused, within ten minutes, intense numbness in the tip of that organ, and also in the lips, with a sensation as though the soft palate and uvula were relaxed and rested on the tongue. The latter symptom continued for about 15 minutes only, but the numbness and tingling endured for 18 hours.

2. Remote Effects.—These are of two kinds, chemical and vital.

a. Chemical effects.—Vogt (*Pharmakodynamik*, bd. i. p. 15) denies that any remote chemical effects can be produced. But for the reasons before detailed, I regard the alteration in the qualities of the urine, by the internal use of acids or alkalis, as the effect of chemical influence. Moreover, the deposition of silver under the skin by the exhibition of the nitrate, and the colour communicated to bones by the use of madder, seem to show that even solids may undergo chemical changes by the internal employment of medicines.

b. Vital effects.—The functions of remote parts are affected by medicines, as when narcotics or diuretics are exhibited:—The former act on the brain, the latter on the kidneys. Inflammation even may be set up in a distant organ,—as of the bladder, by the use of cantharides.
5. Absorption of Medicines.

Proofs.—The particles of most medicinal substances, when applied to the living body, become absorbed and pass into the circulation. Two facts prove this, viz., the disappearance of certain substances from a shut cavity into which they had been introduced,—and the detection of medicinal particles in the blood, secretions, or solids of the body.

a. Disappearance from a shut cavity.—Drs. Christison and Coindet found that four ounces of a solution of oxalic acid injected into the peritoneal sac of a cat, killed the animal in fourteen minutes. On a post-mortem examination, although none of the fluid had escaped by the wound, they found scarcely a drachm remaining.—(Edin. Med. and Surg. Journ. xix. 335).

b. Detection in other parts of the body.—Tiedemann and Gmelin (Versuche über d. Wege auf welchen Substanzen aus dem Magen u. Darmkanal ins Blut gelangen. 1820) have detected the following substances in the blood of animals to whom those agents had been administered: camphor, Dippel’s oil, musk, indigo, rhubarb, lead, cyanuret of potassium, sulphocyanuret of potassium, iron, mercury, baryta, and alcohol. By other experimenters, asafetida, sal ammoniac, iodine, hydrocyanic, and sulphocyanic acids, &c. have been found. (For authorities consult Magendie’s Elementary Compendium of Physiology, and Christison’s Treatise on Poisons).

In the solids of the body several substances have been recognized: for example, madder in the bones, silver in the skin, copper in the liver, lead in the liver, spinal cord, and muscles, mercury in various parts, &c.

In the secretions various medicinal agents have been recognized.—Thus, in the cutaneous secretions, mercury, iodine, sulphur, the odorous matter of musk, of garlic, and of onions, and other substances, have been detected;—in the breath, several substances have been recognized by their odour; for example, camphor, alcohol, ether, phosphorus, asafetida, sulphur, the odorous matter of garlic, and of onions, &c.

The milk sometimes acquires purgative properties, in consequence of the employment of purgatives (senna, for example) by the nurse. Bitters, indigo, iodine, and madder, have also been distinctly recognized in it. In the urine so many substances have been discovered, that it will be most convenient to exhibit them in a tabular form. The following is taken principally from the experiments of Drs. Wöhler and Stehberger, as mentioned by the late Dr. Duncan (Supplement to Edinburgh Dispensatory, 1829.)

SUBSTANCES WHICH PASS OFF BY THE URINE.

(A) Unchanged, or Nearly So.

Salts.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonate of potash</td>
<td></td>
</tr>
<tr>
<td>Nitrate of potash</td>
<td></td>
</tr>
<tr>
<td>Chlorate of potash</td>
<td></td>
</tr>
<tr>
<td>Sulphocyanuret of potassium</td>
<td></td>
</tr>
<tr>
<td>Tartrate of nickel and</td>
<td></td>
</tr>
<tr>
<td>Potash</td>
<td></td>
</tr>
<tr>
<td>Borax</td>
<td></td>
</tr>
<tr>
<td>Chloruret of baryum</td>
<td></td>
</tr>
</tbody>
</table>

Colouring Principles.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indigo</td>
<td>(in 15 minutes)</td>
</tr>
<tr>
<td>Madder</td>
<td>(in 10 minutes)</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>(in 20 minutes)</td>
</tr>
<tr>
<td>Gamboge.</td>
<td></td>
</tr>
<tr>
<td>Logwood</td>
<td>(in 25 minutes)</td>
</tr>
<tr>
<td>Red radishes</td>
<td></td>
</tr>
<tr>
<td>Mulberry.</td>
<td></td>
</tr>
<tr>
<td>Black cherry</td>
<td>(in 45 minutes)</td>
</tr>
<tr>
<td>Cassia Fistula</td>
<td>(in 55 minutes)</td>
</tr>
<tr>
<td>Elder rob</td>
<td>(in 75 minutes)</td>
</tr>
</tbody>
</table>
Odorous Principles somewhat altered.

<table>
<thead>
<tr>
<th>Oil of turpentine.</th>
<th>Asafoetida.</th>
<th>Narcotic principle of Amanita muscaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>— juniper.</td>
<td>Garlic.</td>
<td>Asparagus (Cullen.)</td>
</tr>
<tr>
<td>Valerian.</td>
<td>Castoreum.</td>
<td></td>
</tr>
<tr>
<td>Saffron.</td>
<td>Opium.</td>
<td></td>
</tr>
</tbody>
</table>

Other Matters.

Astringency of Uva ursi (in 45 minutes) Oil of almonds (Bachetoni.)

(B) In a state of combination.

Sulphur, as sulphuric acid and sulphuretted hydrogen.

Iodine, as hydriodic acid or ioduret.

Oxalic

Tartaric

Gallic (in 20 minutes) Acids, appear in combination

Succinic

Benzolic

(C) In a decomposed state.

Tartrate

Citrate

Malate

Acetate

Sulphuret of potassium changed, in a great measure, into the sulphate of potash.

If the accounts published respecting the *Amanita muscaria* (fig. 7) be correct, its effects are most extraordinary. A variety of this fungus has a powerful narcotic or rather inebriating effect; and that the active molecules get into the blood is proved by the fact of the urinary secretion being impregnated with them, and thus possessing an intoxicating property; and we are told that the inhabitants of the northeastern parts of Asia use it for this property. A man, for example, may have intoxicated himself to-day by eating some of the fungus; by the next morning he will have slept himself sober; but by drinking a tea-cupful of his urine he will become as powerfully intoxicated as on the preceding day. "Thus," says Dr. Greville, on the authority of Dr. Langsdorf, "with a very few *Amanita*, a party of drunkards may keep up their debauch for a week;" and "by means of a second person taking the urine of the first, a third of the second, and so on, the intoxication may be propagated through five individuals."

Vessels effecting absorption.—The particles of medicinal and poisonous substances are absorbed by the veins principally, but also by the lymphatics and lacteals.

1. Absorption by the veins.—The circumstances which seem to prove venous absorption are the following:

a. Detection of substances in the venous blood. — Tiedemann and Gmelin (op. cit.) administered a variety of colouring, odorous, and saline substances to animals, mixed with their food, and afterwards examined the state of the chyle, and of the blood of the (splenic, mesenteric, and portal) veins. The colouring substances employed were—indigo, madder, rhubarb, cochineal, litmus, alkanet, gamboge, and sap-green; none of them could
be detected in the chyle, but some were found in the blood and urine. The odorous substances used were—camphor, musk, spirits of wine, oil of turpentine, Dippel's oil, asafetida, and garlic: they were for the most part detected in the blood and urine, but none were found in the chyle. The saline substances tried were—acetate of lead, acetate and cyanurum of mercury, chlorurum and sulphate of iron, chlorurum of barium, and ferrocyanurum and sulpho-cyanurum of potassium. A few of these were detected in the chyle, and most of them in the venous blood and urine. From these experiments we may conclude, that although saline substances occasionally pass into the chyle, odorous and colouring matters do not; all the three classes of substances, however, are found in the venous blood. These results, observe Tiedemann and Gmelin, are opposed to those of Lister, Musgrave, J. Hunter, Haller, Viridet, and Mattei, but agree with those of Hallé, Dumas, Magendie, and Flandrin.

b. Magendie's experiment.—Magendie and Delille (Elem. Comp. Physiol.) performed a striking experiment, with the view of settling, if possible, the question of venous or lymphatic absorption of medicines and poisons. They divided all the parts of one of the posterior extremities of a dog, except the artery and vein, the former being left entire, for the purpose of preserving the life of the limb. A portion of the Upas Tieuté was then applied to a wound in the foot: in the short space of four minutes the effects of the poison were evident, and in ten minutes death took place. To the inferences drawn from this experiment, however, several objections have been stated: first, the exhibition of opium, to diminish the pain of the operation, has been said to vitiate the whole of the experiment; secondly, the coats of the arteries and veins contain lymphatics, by which absorption might be carried on; and thirdly, as the poison was introduced into a wound, the poison might have combined with the blood, and have rendered it deleterious, without the process of absorption taking place. The first two of these objections have been obviated. In a second experiment, Magendie severed the artery and the vein, and reconnected them by quills, so as to preclude the possibility of absorption taking place by the lymphatics of these vessels: the effects were the same. Some years since I assisted my friend Mr. Lloyd, assistant-surgeon of St. Bartholomew's Hospital, in performing an analogous experiment, using Strychnia instead of Upas Tieuté, and without administering opium: death took place in twelve minutes.

c. Lacteals tied: effects of poisons still produced.—Magendie says that symptoms of poisoning were observed in six minutes, when nux vomica was applied to the intestine, though the lacteals had been tied.

d. Blood-vessels tied: poisons do not act.—Segalas tied the veins of a portion of intestine, and applied poison, but no effects were produced. Emmert observed, that when the abdominal aorta was tied, hydrocyanic acid was applied to the foot without producing any effect, but when the ligature was removed, symptoms of poisoning came on. (Müller.)

e. Rapidity of absorption.—Mayer found that ferrocyanurum of potas- sium could be detected in the blood, in from two to five minutes after its injection into the lungs. The rapidity with which this salt enters the blood, says Müller, is too great for it to be explained by means of the slow circulation of the lymph.

These circumstances appear to me to establish the fact of venous absorption.
2. Absorption by the lacteals and lymphatics.—The particles of medicinal and poisonous substances are probably absorbed by the lacteal and lymphatic vessels, as well as by the veins. But the process seems to be slow, and, moreover, is confined to certain agents. Tiedemann and Gmelin, whose experiments I have above referred to, were unable to recognize either colouring or odorous substances in the chyle, but occasionally detected certain salts. The absorption of saline, and non-absorption of colouring matters, have likewise been noticed by others (Müller's Physiology.)

Mechanism of Absorption.—The facts connected with absorption are best explained by assuming the existence of two powers or agencies by which this process is effected;—the one physical, and the other vital.

1. Absorption by physical agency (Imbibition, Magendie; Exosmose and Endosmose, Dutrochet.)—Two fluids separated by an interposed dead membrane, mutually, though not equally, permeate the membrane, so as to become intermixed with each other. If a current of water, coloured by litmus, be allowed to pass from a bottle (Fig. 8, a), through a vein immersed in diluted sulphuric acid, contained in a glass dish (b), into a reservoir (c), the litmus liquor is soon observed to become reddened by its passage through the vein, in consequence of the acid permeating the venous coats. If the relative position of the fluids be altered,—that is, the litmus put in the dish (b) and the acid passed from the bottle (a) through the vein, the litmus will still become reddened, shewing that the acid has passed in this case from within outwards.

But it may be said this effect is cadaveric only; that is, it occurs in the dead but not in the living vessels:—and in support of this view may be urged, the transudation of blood within the blood-vessels, and of bile within the gall-bladder, both of which phenomena are observed after death. Magendie has endeavoured to meet this difficulty with respect to the imbibition of poisons. He exposed and isolated the jugular vein of a dog, placed it on a card, and dropped some aqueous solution of the extract of nux vomica on its surface, taking care that the poison touched nothing but the vein and the card. In four minutes the effects of the substance became manifest, and the dog died. (Magendie's Lectures in the Lancet, Oct. 4, 1834.) It must be admitted, however, that the result of this experiment does not absolutely prove, though it strongly supports, the opinion of the imbibing power of the living vessels; for it might be objected, that the nerves of the venous coats propagated the impression of the poison, and that death took place without absorption; or, that the small veins of the venous coat had taken up the poison. The proof, therefore, should consist in the detection of the poison within the vessel. Now this has been obtained by Magendie: a solution of nux vomica was placed on the carotid artery of a rabbit; but as the tissue of arteries is firmer and less spongy, and their parietes thicker than those of veins, a longer time elapsed before the poison traversed the vessel. In fifteen minutes, however, it had passed, and on dividing the vessel the blood adherent to its inner wall was found to possess the bitter taste of the poison.

With these results before us, we can hardly refuse to admit the imbibing power of the blood-vessels.
bition of living tissues, though I think we may fairly question whether this process can be effected so readily in the living as in the dead tissue.

2. Absorption by a vital agency.—The physical and chemical agencies with which we are at present acquainted are totally inadequate to explain all the phenomena of absorption. We are constrained, therefore, to admit another agency, which we may denominate vital or organic.

Is the absorption of a medicine, or poison, essential to the production of its remote effects?—Magendie and Müller (Physiol. p. 246, et seq.) seem to consider the passage of poisons into the circulation essential to their operation on the system: while Messrs. Morgan and Addison (Essay on the Operation of Poisonous Agents, 1829,) deny that in any case absorption is absolutely necessary for the operation of a poison. "We are not opposed," observe the latter gentlemen, "to the theory of venous absorption, but to that theory which would associate with it the absolute necessity for the admission of a poison into a vein." The following facts will be of considerable assistance to us in forming an opinion on this controverted point:

1. Activity of substances injected into the blood-vessels.—Medicinal or poisonous agents injected into the blood-vessels, exert the same kind of specific influence over the functions of certain organs, as when they are administered in the usual way; but that influence is more potent. Thus tartar emetic causes vomiting, castor oil purging, opium stupor, and strychnia convulsions, when thrown into the veins.

2. Detection of substances in the blood.—All those medicinal and poisonous agents whose sensible or chemical properties enable them to be readily recognised, have been detected in the blood, or in the secretions which are formed from the blood, after their ordinary modes of administration; as by the stomach.

3. Activity of medicines promoted by the means which promote absorption, and vice versâ.—The remote effects of many medicinal and poisonous agents are influenced by the same circumstances that influence absorption; and we are therefore naturally led to presume a mutual relation. Now these circumstances are principally three in number, viz. the nature of the tissue to which the agent is applied—the properties, (physical or chemical) of the medicine itself—and the condition of the system.

a. Nature of the tissue.—Nux vomica acts with the greatest energy when applied to the pulmonary surface,—with less when introduced into the stomach,—and with the least of all, when applied to the skin. The same order of gradation is observed with respect to opium. Now the faculty of absorption, or of imbibition, as Magendie calls it, does not take place with equal intensity in all tissues. Certain physical conditions, (viz., a fine and delicate structure, and great vascularity) enable the pulmonary surface to absorb or imibe with extreme rapidity: in this respect, indeed, it is not equalled by any tissue of the body. Hence, then, if we assume that nux vomica and opium act by becoming absorbed, we can easily comprehend why they are so energetic when applied to this part. The membranous lining the alimentary canal absorbs with less facility than the pulmonary membrane, which may be accounted for by its less vascularity, and by its being covered, in some parts at least, by an epidermoid layer, and in all its parts by mucus, which, to a certain extent, checks absorption. The cutaneous surface, lastly, being covered by an inorganic
membrane (the epidermis,) does not possess the same physical faculties for absorption met with in either of the foregoing tissues; and hence the comparative inertness of medicines when applied to it. In fact, it is only by the long-continued application of these agents to the skin, that we are enabled to affect the general system; and that the obstructing cause is the epidermis, is shewn by the facility with which the system may be influenced when this layer is removed, as has been proposed and practised by Lembert and Lesieur, constituting what has been denominated the endermic or emplastro-endermic method of treating diseases; of which method I shall have occasion to speak hereafter.

b. The physical and chemical properties of the medicine.—Another circumstance, tending to prove some connexion between the activity of a medicine and its absorption is, that the effect of many medicines is in proportion to their solubility. Arsenic and morphia are both more energetic in solution than in the solid state. Now liquids, (particularly those miscible with the blood,) are much more readily absorbed than solids. In the treatment of many cases of poisoning, we endeavour to take advantage of this principle, and by rendering substances insoluble, diminish their activity, or render them quite inert. Thus the antidote for the salts of lead, or of baryta, is a sulphate, the acid of which forms an insoluble salt with either of the bases (lead or baryta.) Tannic acid (or astringent infusions which contain it,) is for the same reason found useful in cases of poisoning by vegetable substances whose active principle is an alkaid; and we employ carbonat of lime as an antidote for oxalic acid, to render this substance incapable of being absorbed.

c. Condition of System.—Magendie asserts, as the result of experiments, that plethora uniformly retards, and depletion as constantly promotes, absorption. If, therefore, we wish to promote this function, we have a ready means of doing so, in blood-letting. Now every surgeon knows that one powerful means of promoting the action of mercurials on the mouth, is to abstract blood; and, therefore, we should be cautious about bleeding a patient, while a poisonous dose of some narcotic, as opium, is in the stomach. Nay, in theory, the best means of preventing the operation of poisons which act by becoming absorbed, would be to throw a quantity of warm water into the veins. Magendie tried this on animals, and found it successful.

4. Magendie's experiment.—The experiment of Magendie, already related, of applying the Upas Tieté to the leg of a dog, connected to the body only by two quills, is another argument in favour of the operation of medicines by absorption: for in this case the action of the poison could have taken place only after it had passed into the blood.

5. Division of the spinal cord.—Some poisons, as hydrocyanic acid, are equally active when applied to the legs of an animal in whom the spinal marrow has been divided. In this case, the effect of the poison could not be the result of its action on the nerves of sensation and voluntary motion. But it may be said the division of the lumbar spine does not prevent the action of poisons by the nervous system, because it does not destroy the action of the excito-motory or sympathetic systems, the nervous branches of which are distributed to the lining membrane of the blood-vessels. I am aware that it is an experiment liable to objection; but, on the whole, it is certainly favourable to the opinion of the operation of poisons by absorption; more particularly when we bear in mind that the motion of the blood is
necessary to the action of the poison; for if the circulation of a part be obstructed, the poison will no longer act. These reasons are, to my mind, conclusive, that in a large number of instances at least, if not in all, the operation of a medicine on remote parts of the system depends on its absorption. Nor can I admit that this opinion is at all invalidated by the arguments and experiments of Messrs. Morgan and Addison.

The principal objections which have been raised to the theory of the operation of medicines by absorption, are the following:—

a. The experiments of Magendie and others, it has been observed, only show that a poison may get into the veins, and do not prove that absorption is essential to the effect. “We must strongly protest,” say Messrs. Morgan and Addison, “against the assumption that, because a poison has been found to enter and pass through a vein, it is thence to be inferred that such a process is, under all circumstances, absolutely necessary to its operation.” But it has been proved that the more absorption is facilitated the more energetic do poisons act, and vice versâ.

b. Mr. Travers, in his Further Inquiry concerning Constitutional Irritation, points out very forcibly the analogy to be observed between the effects of severe injuries and of poisons which operate rapidly on the system. Thus both strychnia and punctured wounds cause tetanus, and he, therefore, concludes their modus operandi must be identical: consequently, as there is nothing to absorb in the one case, so absorption cannot be essential in the other. But although the symptoms caused by the above poison are very analogous to those of traumatic tetanus, yet we are not to conclude that the effects of strychnia and of a puncture are precisely alike. “The fact of two substances producing similar symptoms in one organ,” observes Müller (op. cit. p. 56) “does not prove that these substances produce exactly the same effects, but merely that they act on the same organ, while the essential actions of the two may be very different.” And I confess I see nothing unphilosophical in supposing that the same morbid condition of a part may be induced in more than one way: for as every part of the organism depends for the performance of its proper functions on the receipt of arterial blood and of nervous influence, so alterations in the supply of either of these essentials may modify or even suspend the functions of a part.

c. Messrs. Morgan and Addison tell us that the blood circulating in the carotid artery of a dog poisoned by strychnia is not poisonous to a second dog, and they therefore infer that this poison does not act on the brain by absorption, but by an impression upon the sentient extremities of the nerves.

By the aid of a double brass tube, (fig. 9,) consisting of two short brass cylindrical tubes to each of which a long handle is attached (fig. 11), they established a complete circulation between the carotids of a poisoned and of a sound dog, by connecting the lower and upper ends of the divided arteries in both animals, so that each supplied the brain of the other with the portion of blood which had previously passed through the carotid artery to his own, and, consequently, the poisoned dog in this case received from the unpoisoned animal a supply of arterial blood equal to that with which he was parting. (Fig. 10.) One of the dogs was then inoculated with a concentrated preparation of strychnia, which had been found upon other occasions to produce death in these animals in about three minutes and a half. In three minutes and a half the inoculated
animal exhibited the usual tetanic symptoms which result from the action of this poison, and died in little less than four minutes afterwards, viz. about seven minutes from the time at which the poison was inserted, during the whole of which period a free and mutual interchange of blood between the two was clearly indicated by the strong pulsation of the denuded vessels throughout their whole course. The arteries were next secured by ligature, and the living was separated from the dead animal; but neither during the operation, nor subsequently, did the survivor show the slightest symptom of the action of the poison upon the system.

The inference which has been drawn from this experiment is, that the arterial blood of an animal under the influence of poison is not poisonous. But it appears to me that this is not a necessary inference, and as it is opposed to the result of other experiments, it requires careful investigation ere we admit it. Vennière has proved that if the extract of nux vomica "be thrust into the paw of an animal after a ligature has been tightened round the leg, so as to stop the venous, but not the arterial circulation of the limb, blood drawn from an orifice in a vein between the wound and ligature, and transfused into the vein of another animal, will excite in the latter the usual effects of the poison, so as even to cause death; while, on the contrary, the animal from which the blood has been taken will not be affected at all, if a sufficient quantity is withdrawn before the removal of the ligature."—(Christison's Treatise on Poisons, 3d ed. p. 10.)

Mr. Travers, (op. cit.) in noticing the different results obtained by Vennière and Messrs. Morgan and Addison, observes, that "if it be required why the poisoned blood concentrated below a ligature, and transferred into the vein of a healthy animal, proves destructive, while the blood of their common circulation affects only the one of the two animals which is the subject of the inoculation, the answer is obvious—that either

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**Fig. 9.** Double Brass tube. **Fig. 10.** Double circulation between the Carotids of a poisoned and a sound dog. **Fig. 11.** Single cylindrical Brass tubes.
the mechanical impulse fails, or the activity of the poison is exhausted before, in the latter case, it reaches the second animal."

A remarkable error pervades the whole train of reasoning adopted by Messrs. Morgan and Addison, and vitiates some of their conclusions. They assume that Magendie considers actual contact with the brain as essential for the operation of the Upas poison; (see pp. 42, 43, 47, 49, &c. of the Essay.) This assumption, however, is not correct. "In 1809," says Magendie (Formulaire, 8me ed. p. i.) "I laid before the first class of the French Institute, a series of experiments which had conducted me to an unexpected result, namely, that an entire family of plants (the bitter Strychnos) have the singular property of powerfully exciting the spinal marrow, without involving, except indirectly, the functions of the brain." Now, this being Magendie's opinion, it is evident that, in the experiment performed by Messrs. Morgan and Addison, the blood sent from the carotid artery of the poisoned animal to the brain of the sound one could only reach the spinal marrow by the usual route of the circulation; that is, it must be returned by the jugular veins to the heart, from thence to the lungs, back again to the heart, from thence into the aorta, and then distributed through the system. Now it is not too much to suppose that, during this transit, some portion of the poison might be decomposed or thrown out of the system before it could arrive at the spinal marrow; and even if this were not the case, this organ could only receive a small quantity of the poison contained in the system, namely, that sent by the vertebral to the spinal arteries. Hence we ought to expect that a poison thrown into the arteries will operate less powerfully than when thrown into the veins, unless it be into the arteries supplying the parts on which the poison acts. Moreover, as an anonymous reviewer has observed (Lond. Med. and Phys. Jour. vol. lxiii.) it is to be recollected that as the carotid artery, in its healthy state, is little more than one-fourth of the calibre of the vessels carrying blood directly to the brain, consequently the dog not inoculated was subject to the influence of one-fourth only of the quantity of the poison which was conveyed to the brain alone of the inoculated animal. Furthermore I would add, that it is not too much to suppose that the circulation of the blood through the tube would not be so free as through the artery.

How do medicines and poisons which have entered the blood vessels affect distant organs?—Viewing the question theoretically, we see three ways by one or more of which remote parts might be conceived to become affected after medicinal globules have passed into the blood.

1. By modifying or altering the properties of the blood, and thereby unfulfilling it for carrying on the functions of the body.—Although no facts are known which can be regarded as absolutely proving that the action of medicines or poisons is primarily on the blood, yet none I believe are inconsistent with such a notion in all cases, while several strongly favor it: and it has been justly observed by Andral (Treatise on Pathological Anatomy, translated by Drs. Townsend and West, vol. i. p. 642), that "as the blood nourishes the solids, and as without its presence they cannot support life, the state of the solids cannot but be influenced by the state of the blood."

In the first place, it must be admitted that in many diseases the properties of the blood are altered, and in some cases these alterations after
appear to be primary; that is, they precede alterations of the solids.—Secondly, in some diseases the blood acquires poisonous properties, and is capable of transmitting the affection of the individual from whom it was taken.—Thirdly, by the use of poisons, medicines, and particular kinds of diet, the properties of the blood become altered, while at the same time the condition of the solids is modified. Now as from the food is formed the chyle; from the chyle the blood, and from the blood the solids, a necessary connexion must exist between the quality of the ingesta and the condition of the solids. For facts and arguments relative to these positions, I must refer to Andral’s work before quoted.

But if medicines or poisons introduced into the torrent of the circulation act primarily on the blood, what, it may be asked, are the effects produced?

In some cases the action is mechanical, as when air is introduced into a vein. "A very small quantity of air," says Magendie, (Lancet, Nov. 15, 1834) "passed slowly into a vein, mixes with the blood, traverses the lungs, and is exhaled with the pulmonary transpiration, without causing any remarkable accident; but when the quantity is increased, especially in a sudden manner, the air mixes with the blood contained in the heart, and forms with it a foamy kind of liquid, which does not pass readily through the capillary system of the pulmonary artery. In consequence of this obstacle to the passage of the blood through the lungs, the respiration and circulation become necessarily troubled, and the animal soon dies in a state of asphyxia,—not from any pernicious action of the air on nervous system." (For further information On the Influence of Air in the Organs of Circulation, see Dr. J. R. Cormack’s Prize Thesis on this subject; Edin. 1837.) Water, when introduced into the circulation, probably acts merely as a dilutent. For though when mixed with blood out of the body it dissolves the envelope of the red particles, we can hardly suspect that it produces a similar effect within the blood-vessels, from the circumstance that large quantities of water may be thrown into the veins without causing any remarkable disorder of system; whereas if the globules were deprived of their envelope, or changed in their form, great disorder of the system might be expected. Solutions of various substances (as sal ammoniac, chloruret of sodium, carbonate of potash, sugar, &c.) produce no change in the globules out of the body; they therefore probably act mechanically on the blood.

Some substances exercise a chemical action on the blood; as the mineral acids, the alkalis, various metallic salts, alcohol, &c. The affinity of these agents is principally directed to the fibrin and albumen of the liquor sanguinis, and to the constituents of the globules. Hydrocyanic acid even would appear to be a chemical agent, since it makes the blood oily, fluid, and bluish in colour. Such substances, therefore, as exercise a chemical influence, cause speedy death when they are thrown into the veins, unless, indeed, the quantity introduced be very small. It is possible that organic substances may, as Dr. Christison supposes, be decomposed in the blood, without that fluid undergoing any apparent change. "A very striking proof of this is furnished by oxalic acid. Dr. Coindet and I, in one of our experiments, injected into the femoral vein of a dog, eight grains and a half of oxalic acid, which caused death in thirty seconds. Here it was impossible that the poison could have passed off by any of the excretions; yet we could not detect even that
large proportion in the blood of the iliac vein, and vena cava, collected immediately after death. As the blood possessed all its usual properties, we must suppose that the poison underwent decomposition in consequence of a vital process carried on within the vessels."—(Treatise on Poisons, 3d ed. p. 16.)

It must not, however, be assumed, that agents which effect chemical changes in the blood out of the body, or when injected into the veins, necessarily produce the same phenomena when absorbed from the intestinal or other surfaces; for the quantity taken up at any one time by this process is small in proportion to the volume of the circulating fluid, and the affinities between these agents and the constituents of the blood seem to be kept in check by the vital properties.

As the blood is a vital fluid, medicines may effect changes in it which are neither mechanical nor chemical. Strychnia and morphia produce no obvious effect on the blood, yet it is not impossible that they may cause some changes in its vital condition; and that to these, part of the symptoms caused by their use are to be referred. Here, however, all our remarks are but conjectural.

2. By pervading the structure of the organ acted on.—The usual mode of explaining the action of medicines after their absorption, is, that when they have got into the blood, they are carried in the ordinary course of circulation to the heart, and from thence to the lungs. Here the blood undergoes certain chemical changes, and is probably deprived of part of the medicinal particles; at least this appears to be the case with respect to certain odorous substances. The blood still impregnated with medicinal particles being returned to the heart, is transmitted from thence to all parts of the system. In their passage through the tissues of the different organs, it is presumed that these particles act on one or more parts which are endowed with a peculiar susceptibility to their influence.

Thus the opiate particles are supposed to exert a specific influence on the cerebral tissue; strychnia is thought to act on the grey matter of the spinal marrow; mercury, on the salivary glands; diuretics, on the kidneys; and so on. Müller supposes that a change is effected on the composition of the organic matter of the part acted on. The molecules are ultimately got rid of by the excretory organs. On this supposition, then, the blood is merely the "vehicle of introduction."

It must be admitted, that this theory, plausible as it may appear, cannot be satisfactorily proved. We may adduce several arguments in favour of it, but absolute proof or demonstration cannot be offered: our facts merely show the passage of medicinal particles into the blood, and the affection of the remote organs; but the link which connects the two phenomena cannot be, or at least has not yet been, demonstrated. The strongest argument in favour of this mode of explanation is, that the molecules of certain medicines may be detected in some one or more of the excreted fluids; while, at the same time, the functions of the organs secreting or excreting these fluids, have become influenced by the medicine. Now the simplest, and therefore the most plausible explanation, is, that the molecules, in passing through the organ, acted on its tissue, and thus gave rise to a functional change. The diuretic effects of nitre, alkalis, turpentine, &c., are readily explained on this theory: but when the affected part is not a secreting organ, and especially when the medicinal agent is not readily detected by its phy-
sical or chemical properties, we have not the same evidence to offer in support of this view, which, notwithstanding, may be not the less true. Several objections present themselves to this explanation. Many medicinal substances may be detected in the secretion of an organ, though no evident influence has been exercised over the organ itself. Thus the colouring particles of rhubarb may be recognised in the urine, although the action of the kidneys does not appear to be altered; and therefore it may be said, that in those cases where the quality of the secretion is affected, we have no right to infer that it depends on the passage of medicinal particles through the secreting vessels. This objection, however, deserves but little attention, inasmuch as we know that the susceptibility of the same part is not the same to all medicines; for it is not every medicine which produces vomiting when applied to the stomach.

It has also been said that this theory of medicines "being conveyed by the circulation to particular parts, is utterly gratuitous, and no less improbable." "What intelligence," says an American writer, (Chapman's *Elements of Therapeutics*, 4th ed. vol. i. p. 73,) "directs them in this voyage of circumnavigation to the port of destination; and how, on their arrival (admitting it to happen,) are they separated from the great mass of fluids in which they are enveloped?" It is not supposed, on this theory, that medicines are conveyed to particular parts, but to every part of the body in which the blood circulates. How then, it may be replied, is it that particular parts only are affected, since medicinal molecules are in contact with every part? We do not pretend to account for this circumstance. Every one is familiar with the fact that carbonic acid may be applied to the stomach in large quantity with impunity; whereas, if taken into the lungs, it acts as a narcotic poison. The urine has very little effect on the bladder, but if introduced into the cellular tissue, gives rise to violent inflammation.

I have already alluded to another objection to this theory—namely, that injuries sometimes produce the same symptoms as poisons. But it must be recollected that in a large number of instances injuries do not produce the same symptoms; and in those cases where the effects of the two are analogous, I see no difficulty in assuming that there are two modes of affecting the nervous system.

The most important objections that have been advanced against the operation of medicines through the circulation, by local contact with the tissues, are those founded on the experiments of Messrs. Morgan and Addison. Of all their experiments, the following are, I conceive, the strongest against the theory under examination:

The jugular vein of a full-grown dog was secured by two temporary ligatures; one of which was tied round the upper, and the other round the lower part of the exposed vein. The vessel was then divided between these two ligatures, and the truncated extremities re-connected by means of a short brass cylinder or tube (fig. 13,) within which was placed a portion of woorara, of the size of a grain of canary-seed (fig. 12.) Both the temporary ligatures were then removed (fig. 14), the accustomed circulation through the vessels was re-established, and in forty-five minutes the animal dropped on the ground, completely deprived of all power over the muscles of voluntary motion: in two minutes, convulsions and inspiration had entirely ceased. This result was to be expected, whatever theory be adopted.
In another experiment two temporary ligatures were applied to the jugular vein, as in the former case. A cylinder of quill, containing a little woorara, was then introduced into the vein between the two ligatures; another ligature was then applied (fig. 15), and the upper temporary ligature removed (fig. 16). In the space of 108 seconds after the removal of the ligature, the animal dropped in convulsions, as in the former case, and expired in 3½ minutes. Now, in this experiment, the direct entrance of the poisoned blood into the heart, &c. was prevented by the lower ligature: hence, if this poison operated by contact with the brain, a greater length of time was necessary for its effects to be produced; inasmuch as the circulation was no longer going on through the trunk of the jugular itself, and therefore, if the poison acted by actual contact, it must have got into the system by the vessels of the vein. This experiment, however, cannot be regarded as conclusive. For although the “result is certainly different from what might have been anticipated, on the supposed position of the circulation of the poison in the blood being essential to its action, yet we cannot regard it as a conclusion against that supposition, unless it were shown that the poison, when the ligature above it is removed, and when it mingleth itself with the stream of blood in the vein, does not taint this blood as far back as the next anastomosing branch, and so make its way forward to the heart. That this is not the effect of removing the farther ligature, is not shown by these authors; and their other experiments in favour of their peculiar doctrine of the mode of action of poisons, we have no difficulty in pronouncing to be inconclusive.”—(See a criticism in The British and Foreign Medical Review vol. v. for Jan. 1837.)

3. By acting on the lining membrane of the blood-vessels.—Messrs. Morgan and Addison contend, that when poisons are “introduced into the current of the circulation in any way, their effects result from th
impression made upon the sensible structure of the blood-vessels, and not from their direct application to the brain itself."—(Essay, p. 60.) The proofs adduced in support of this theory are, first, "the extreme susceptibility of the inner coat of a vein, when exposed to the action of a poison," as shown by the experiment related at page 26: secondly, that woorara acts on the brain as quickly when injected into the femoral, as when thrown into the carotid artery: thirdly, that woorara, applied to the cut surface of the cerebrum, caused no symptoms of poisoning: fourthly, that by establishing a complete double circulation between the carotids of a poisoned and of a sound dog, the latter does not become affected.

Of all these "proofs," however, the only important, though not unobjectionable one, is the first. The second and third are merely negative; their object being to show that poisons do not act by pervading the structure of the part, and to the fourth I have before offered some objections.

In conclusion, then, I would observe, that while Messrs. Morgan and Addison have thrown some doubt over our previously received notions on the operation of medicines, they cannot be admitted to have established their own hypothesis; and further experiments are still required to settle this doubtful question.


Messrs. Morgan and Addison contend, "that all poisons, and perhaps, indeed, all agents, influence the brain and general system, through an impression made upon the sentient extremities of the nerves, and not by absorption and direct application to the brain." Müller, on the other hand, asserts, "that before narcotic poisons can exert their general effects on the nervous system, they must enter the circulation."

Difficulties are met with by exclusively adopting either of these opinions. The operation of some medicines seems to be best explained by supposing the previous absorption of these agents, while that of other substances appears to be most satisfactorily accounted for by presuming they affect the nerves independently of absorption.

Proofs that Some Substances Act Independently of Absorption.—Several circumstances lead us to infer that, in some instances, substances act on the general system without necessarily undergoing absorption.

a. The instantaneous operation of some Poisons.—One drop of pure hydrocyanic acid, says Magendie, placed in the throat of the most vigorous dog, causes it to fall dead after two or three hurried inspirations. If the nose of a rabbit be introduced into a receiver filled with hydrocyanic acid vapour, the animal drops dead instantly. Sir Benjamin Brodie once happened to touch his tongue with the end of a glass rod which had been dipped in the essential oil of bitter almonds; scarcely had he done so, before he felt an uneasy, indescribable sensation at the pit of the stomach, great feebleness of limbs, and loss of power to direct the muscles, so that he could hardly keep himself from falling. These sensations were quite momentary. In the cases now quoted the rapid action of the poisons seems almost incompatible with the idea of their absorption. Müller, however, thinks otherwise, and asserts they are explicable on the theory of absorption by imbibition. "The rapid effects of prussic acid," he observes, "can only be explained by its pos-
sessing great volatility and power of expansion, by which it is enabled to
diffuse itself through the blood more rapidly than that fluid circulates, to
permeate the animal tissues very quickly, and in a manner independent of
its distribution by means of the blood, and thus to produce the pecu-
liar material changes in the central organ of the nervous system more
quickly in proportion as it is applied nearer to it.”—(Op. cit. p. 247.)

b. The effects being disproportionate to the facility for absorption.—
Orfila (Toxicologie Générale) says, that alcohol acts with much less
energy when injected into the cellular texture, than when taken into the
stomach; and as the power of absorption is greater in the former than in
the latter part, he concludes that the remote action of alcohol must be
produced by the agency of the nerves. Opium, on the contrary, is sup-
posed to operate by absorption, because it is more active when injected
into the cellular texture of the thigh than when taken into the stomach.

c. Dilution diminishing the remote effects.—The effect of dilution on
the action of medicinal and poisonous agents oftentimes assists us in
determining the mode by which the remote effects take place. Thus if
we apply a strong mineral acid to the stomach, great disorder of the
general system is produced; but if we dilute the acid previous to its
exhibition, little disturbance in the system is observed. Now as dilution
facilitates absorption, it is improbable that the constitutional disorder
carried by swallowing strong mineral acids depends on their absorption.
On the other hand, Dr. Christison (op. cit.) has shown that oxalic acid,
considerably diluted, quickly enters the blood, and causes speedy death:
hence it is presumed to kill in consequence of absorption.

d. Effect of Mechanical Injury.—Mechanical injuries sometimes give
rise to effects on remote parts similar to those caused by the action of
certain medicines or poisons. Laceration of the stomach produces similar
constitutional disorder to that occasioned by the strong acids.

Agency of the Nervous System.—Between the individual parts of
the organism there exist certain relations or connexions, which Adelon
(Physiologie de l'Homme, t. 4me, p. 200,) has arranged in three classes,—
the mechanical, the functional, and the sympathetic. It frequently happens
that one organ in the performance of its functions exercises a mechanical
influence over another. Thus the motions of the respiratory muscles
have an important influence over the circulation of blood within the
chest. By the contraction of the muscles of the fore-arm, pressure is
made on the deep-seated veins, and the passage of blood through them
thereby obstructed. These, then, are evident and clear cases of a mecha-
nical relation between certain organs. We have also numerous instances
of what have been called functional relations; but one example will
suffice: the liver cannot secrete bile if the supply of arterial blood, or of
nervous energy, be cut off: hence it is evident that the function of the
liver depends for its performance on the proper execution of the functions
of the arterial and nervous systems. But there is a class of relations
which cannot be referred to either of the preceding heads, and which
have been called the true sympathies, or the sympathetic relations. Thus
if we titilate the mucous membrane of the nose, sneezing is produced;
if the soft palate, vomiting.

The phenomena hitherto called sympathetic have been denominated
by Dr. Marshall Hall (Memoirs on the Nervous System, 1837,) excito-
motory. They must not be confounded with those of sensation and
operation, from which they are quite distinct. They are effected by nervous fibres and a nervous centre. The fibres are of two kinds, one termed incident excitor, the other reflex motor. The centre is the grey matter of the true medulla oblongata and medulla spinalis, from which the nervous fibres arise.—(See Grainger’s Observations on the Structure and Functions of the Spinal Cord, 1837.) The mode of action of these parts is this: when a physical agent is applied to any of the external or internal surfaces of the body, an impression is made on, and carried by, the incident excitor nerve to the grey matter, constituting the nervous centre of the system; and this part, by its peculiar power, excites contraction through the medium of its reflex motor nerves. Electricity has been suspected to be the secret agent effecting these communications.

When the nostrils are stimulated, the fauces irritated, or cold water flashed upon the face, filaments of the fifth pair of nerves are the incident exciters; when carbonic acid, or a drop of water, comes in contact with the larynx, and when the dust of ipecacuanha is inhaled into the bronchia, with the effect of inducing asthma, filaments of the pneumogastric nerve are the incident exciters. In all these instances filaments of the pneumogastric are the reflex motors, by means of which the actions of sneezing, vomiting, sobbing, closure of the larynx, and asthma, are produced. “It is singular,” observes Dr. Hall, (Lectures on the Nervous System, p. 156, note,) “that ipecacuanha, taken into the stomach, should excite vomiting, and, inhaled into the bronchia, should excite spasmodic asthma, equally, as it would appear, through the pneumogastric nerve.” Belladonna applied to the eyebrow causes dilatation of the pupil: the incident exciters concerned in this process are the fibres of the portio major of the fifth,—while the reflex motors are derived from the third or pectoral-motor nerve. In cases of poisoning by this substance, difficulty or impossibility of deglutition has been observed,—another effect of its action on the excito-motory system.

Mr. Grainger is of opinion, that the ganglions of the sympathetic form a part, though to a certain degree an isolated one, of the excito-motory system; and that their action is excited like that of the spinal cord.—Op. cit. p. 136, et seq.) He has also suggested (op. cit. pp. 131-2, 155-157,) that the motions displayed by plants and the lower animals are excited, and not voluntary; and that even in plants it may be effected by a structure analogous in its office, though differing in its physical characters, to the true spinal system of animals. Hitherto, however, no one has been able to demonstrate a nervous system in vegetables. Dutrochet (Recherches anatomiques et physiologiques sur la structure intime des Animaux et des Végétaux, 1824,) indeed asserts, that the small points, or spots, observed on the cells and vessels of plants (figs. 17 and 18.) are analogous to the nervous globules of animals; he calls them nervous corpuscles, and regards them as the scattered elements of a diffused nervous system. That globules are found in vegetables in the situation described by Dutrochet no one can deny; but the grounds on which he asserts them to be nervous are very slender. The researches of Leeuwenhoek, Prochaska, Fontana, Sir Everard Home, Bauer, the brothers Wenzel, and Dr. Milne
Edwards, he observes, have shewn that the nervous system of animals is composed essentially of agglomerated globular corpuscles.

If we examine, by the aid of a simple microscope, the pulpy matter of which the oesophageal ganglia of the great or vineyard snail (Helix pomatia) or of the red slug (Limax rufus) is made up, it is seen to be composed of agglomerated globular cells, on the sides of which are numerous globular or ovoid corpuscles (fig. 19.) In form and chemical properties, says Dutrochet, these corpuscles agree with those found in plants. Moreover, in the lower tribes of animals (the Acrita) we observe no nervous filaments; the nervous system consisting merely of the diffused or scattered corpuscles (as in the Hydra or fresh-water polype, fig. 20, and in Vorticella Convallaria, fig. 21; thus presenting another analogy between the nervous corpuscles of animals and the globular bodies of plants.

On these grounds, then, Dutrochet assumes that the little globules sticking to the cells and vessels of plants, and which are nothing but particles of amylaceous, ligneous, or resinous matter, are to be regarded as the scattered elements of a diffused nervous system.

7. Parts affected by the remote action of Medicines.

The remote effects of medicines consist of alterations in the functions of one or more organs more or less distant from the parts to which these agents were applied. Although an alteration of function presupposes an organic change, yet the latter is not always obvious.

A medicine may affect a distant organ directly or indirectly. The stupor caused by opium is presumed to arise from the direct influence exercised by this drug over the cerebrum, since it cannot be otherwise
accounted for. The convulsions produced by strychnia are best explained, not by ascribing them to any direct influence of this agent over the muscles, but to an influence exercised over the excito-motory system, which is functionally related to the muscles.

Some medicinal agents confine their remote influence principally to one organ, and affect the general system only through the relations existing between the affected organ and the other parts of the body. This is remarkably the ease with the substance just referred to,—strychnia. Other agents affect several organs, as arsenic and mercury. We can readily believe that some may affect the whole system, by altering the qualities of the blood. "In fact, when all the tissues thus receive a irritated blood, is it not consistent with sound physiology to admit that their regular modes of vitality, nutrition, and secretion, must be more or less deeply modified? We must either admit this conclusion, or deny the influence which, according to every physiologist, the blood exerts over each solid. It may, then, happen that one or more organs are affected in a more decided manner than the rest, and there may thus be produced in them various lesions that are only accidental and secondary; but it is not in these lesions the origin of the affection lay; it is not on them all the symptoms depend; nor, lastly, is it to them alone we are to have recourse, to throw a light upon the true nature of the disease, as well as upon the treatment proper to be pursued." (Andral's Pathol. Anat. By Drs. Townshend and West, vol. I. p. 663.)

The intimate relations existing between the different organs and functions, make it exceedingly difficult, and, in many cases, even impossible, to distinguish between the direct and indirect influence of a medicine. In the following examples of organs and functions affected by medicines, this distinction has not been attempted:

1. **Nervous System.**—Opium causes sleep and stupor,—alcohol inebriates and disturbs volition,—aconite diminishes feeling,—conia paralyses,—strychnia and brucia convulse.

2. **Circulating System.**—The frequency and force of the circulation is increased by the agents termed excitants, calefacients, or stimulants, but diminished by sedatives. Preternatural heat is reduced by refrigerants. On the influence of asafoetida, digitalis, and senega, on the functions of the heart, see Continental and British Medical Review, Vol. I. p. 27.)

3. **Respiratory System.**—The frequency of respiration is diminished by narcotics. Emetic tartar and corrosive sublimate, used as poisons, inflame the lungs. Expectoration is promoted by the agents termed expectorants.

4. **Digestive System.**—Salivation is produced by mercury. The power of deglutition is diminished or destroyed by belladonna, when employed in poisonous quantities. Vomiting is caused by emetics. Digestion is promoted by condiments and the bitter tonics, but checked by opium. Purging is effected by cathartics,—constipation by opium and vegetablestringuats. Mercury and aloes are believed to stimulate the liver.

5. **Secreting and exhaling organs.**—Mercurials and the alkalis increase the activity of all the secreting and exhaling organs. The oleo-resins and balsams stimulate the mucous surfaces. Opium diminishes the mucous secretions. Diuretics promote the secretion of urine,—diaphoretics the utaneous exhalation,—sialagogues the flow of saliva,—emmenagogues the catamenial secretion,—expectorants the bronchial secretions, &c.
6. Lymphatic System.—Iodine, bromine, mercury, and the alkalis, are presumed to increase the activity of the lymphatic system.

7. Muscular System.—The tone of this system is promoted by cinchona. Strychnia convulses, conia paralyses the muscles.

8. Sexual System.—The sexual feelings are supposed to be excited by phosphorus. The catamenial discharge is promoted by emmenagogues. Parturition is assisted by ergot of rye.

9. The Urinary organs.—Diuretics increase the secretion of urine. Alkalis and acids alter the qualities of this fluid. Opium diminishes the contractility of the ureters and bladder. Cauharides irritate the bladder. The oleo-resins affect the urethra, and cure blennorrhagia.

8. Of the nature or quality of the actions induced by Medicines.

Medicinal agents may increase, diminish, or alter the vital actions, and, consequently, may be arranged in the three classes of stimulants, contra-stimulants or sedatives, and alteratives.

a. Stimulants.—In a therapeutic sense, says Müller, (op. cit. p. 62,) a stimulant is an agent which vivifies the organs, and renovates their composition. "Besides the vital stimuli before alluded to, there are other agents which, under certain conditions, exert a local, vivifying, and strengthening influence: they produce this effect by restoring the composition of the organ by their ponderable or imponderable influence, or by so changing its composition that the renovation by the general vital stimuli is facilitated. All this, however, depends on the state of the diseased organ; and the cases in which the so-called stimulant and tonic remedies have really their supposed effect, are very rare."

Many other agents are called stimulants, although they have no renovating influence, and do not vivify except by exciting re-action, and which, by long-continued operation, destroy, instead of restoring, the powers of the system.

b. Contra-stimulants, or sedatives.—These are agents whose action is the reverse of that of stimulants.

c. Alteratives.—These are neither stimulants nor contra-stimulants merely. They produce some unnatural or morbid change in the organic textures, and consequently occasion alteration of function. This class includes nearly the whole of the articles comprising our materia medica.

Brunonian theory.—The theory of Dr. John Brown supposes that all living beings possess a peculiar principle, termed excitability, and which distinguishes them from inanimate bodies. The agents which support life are termed exciting powers; and these acting upon the excitability, maintain life; in the language of Brown, produce excitement. Whatever can modify the excitability, and produce a greater or less degree of excitement, are termed stimulant powers: these are either universal or local. When the exciting powers act moderately, health is produced: when they act with too great energy, they cause indirect debility: when with too little, they produce direct debility. According to this doctrine, all medicines are stimulants, and differ from each other in little more than the degree in which they exert their stimulant power: moreover, they cannot cause exhaustion (of the excitability) except by an excessive action; in other words, by producing previous over-excitement.—(The Works of Dr. John Brown, by Dr. W. C. Brown, 1804.)
Considered in a therapeutical point of view merely, the following objections present themselves to this theory:—1. Many agents produce exhaustion without previously occasioning any obvious over-excitation (as the respiration of sulphuretted hydrogen or hydrocyanic acid gases):—
2. Medicines differ from each other in something more than the degree of their power; compare together foxglove, ammonia, hydrocyanic acid, cinchona, mercury, alcohol, elaterium, and opium:—3. The great majority of our medicines act neither as stimulants nor sedatives merely; they alter the quality of the vital actions: and this alterative effect has been quite overlooked by the Brunonians.

Theory of Contra-stimulus—New Italian doctrine.—This theory may be considered as a modification of the preceding. It was founded about the commencement of the present century, principally by Rasori and Borda, and was subsequently adopted by Tommasini and other Italians.

It admits two classes of medicines, stimulants and contra-stimulants, thus obviating one of the objections to the doctrine of Brown. An agent that counteracts the effects of some well-known and well-characterized stimulant is denominated a contra-stimulant. The following is a list of remedies classified according to these principles:

**Stimulants.**

|----------|--------|-------|----------|-------------|--------|----------|-------|----------|

It will be perceived that the founders of this doctrine have assembled, under the same head, agents causing the most opposite effects: for example, animal food and opium, aromatics and alcohol, cold and turpentine, hydrocyanic acid and cantharides. Moreover, they have separated others whose general operation is very analogous;—as musk and valerian; opium and *Lactuca virosa*; aromatics and pepper. In their anxiety to find stimulants and contra-stimulants, they have quite overlooked the large and important class of alteratives. They have taken no notice of the physiological effects of medicines, but have directed their whole attention to curative influences, which are accidental and uncertain: for the agents which they have collected under the head of contra-stimulants do not always, or even frequently, relieve excitement; on the contrary, they often have the reverse effect.

There is one part of the theory that deserves especial notice. It is asserted that the dose of a contra-stimulant should be proportioned to the degree of excitement; for when the inflammatory action runs high, the patient will bear enormous doses without any obvious evacuation from the skin, stomach, or bowels, and the disease will be subdued wholly by the contra-stimulant effect upon the fibres and other solids of the body. This capability of bearing large doses has been termed tolerance of medicines;—and, of course, if the theory be true, ought to decrease as the disease
declines; but this certainly does not generally hold good with respect to
ematic tartar, as will be mentioned hereafter. Dr. Marshall Hall
(Researches relative to the Morbid and Curative Effects of Loss of Blood,
1830, also, Introductory Lecture, 1834,) maintains, that while a man in
health can lose a given quantity of blood (say 3xv.) without fainting,
the same individual, affected with congestion of the brain or inflammation,
can bear a much larger quantity (as from 3xxx. to 3l.) before inci-
pient syncope,—while in fever, intestinal irritation, dyspepsia, or cholera,
a smaller quantity (as from 3vi. to 3xii.) will occasion fainting:—so that
congestion and inflammation augment, while fever, cholera, &c. diminish
the tolerance of blood-letting; he therefore makes use of this circumstance
as a diagnostic to enable him to distinguish irritation from inflammation.

9. Circumstances which modify the effects of Medicines.

The circumstances which modify the effects of medicines may be
arranged under two heads; those relating to the medicine, and those
relating to the organism.

1. RELATING TO THE MEDICINE.—Under this head are included,—

a. State of Aggregation.—The state of aggregation of a medicine mo-
difies the effect. Thus morphia is more active in solution than in the
solid state.

b. Chemical combination.—The soluble salts of the vegetable alkalis
are more active than the uncombined alkalis, and vice versa, the insoluble
salts are less active. Lead and baryta are rendered inert by combination
with sulphuric acid.

c. Pharmaceutical mixture.—The modifications produced by medi-
cinal combinations have been very ably described by Dr. Paris.—
(Pharmacologia, 6th ed. vol. i. p. 267.) The objects to be obtained, he
observes, by mixing and combining medicinal substances, are the fol-
lowing:—

I. To promote the action of the basis or principal medicine:—

A. By combining together several forms or preparations of the same substance: as
when we conjoin the tincture, decoction, and extract of cinchona in one formula.
B. By combining the basis with substances which are of the same nature, that is,
which are individually capable of producing the same effect, but with less energy
than when in combination with each other: as when we prescribe a compound
of cassia pulp and manna.
C. By combining the basis with substances of a different value, and which do not
exert any chemical influence upon it, but are found, by experience, to be capable
of rendering the stomach, or system, or any particular organ, more susceptible of
its action: as when we combine mercury with antimony and opium, to increase
the activity of the former.

II. To correct the operation of the basis, by obviating any unpleasant effects it might
be likely to occasion, and which would pervert its intended action, and defeat the
objects of its exhibition.

A. By mechanically separating, or chemically neutralizing, the offending ingre-
dient; as by digesting Cetraria Islandica in an alkaline solution, in order to
remove the bitter principle, and to enable us to obtain a tasteless, but highly
nutritious feocha.
B. By adding some substance capable of guarding the stomach or system against
its deleterious effects; as when we combine aromatics with drastic purgatives, to
correct the gripping qualities of the latter;—or opium with mercurials, to prevent
the latter affecting the bowels.

III. To obtain the joint operation of two or more medicines.

A. By uniting those substances which are calculated to produce the same ultimate
results, although by totally different modes of operation: as when we combine
digitalis and potash to produce diuresis,—the first acting on the absorbents, the second on the secreting vessels of the kidneys.

B. By combining medicines which have entirely different powers, and which are required to obviate different symptoms, or to answer different indications: as when we combine opium and purgatives in painter's colic,—the first to relieve the spasm, the second to evacuate the contents of the intestinal canal.

IV. To obtain a new and active remedy not afforded by any single substance.

A. By combining medicines which excite different actions in the stomach and system, in consequence of which new or modified results are produced: as when we combine opium (a narcotic) with ipecacuanha (an emetic) to obtain a sudorific compound.

B. By combining substances which have the property of acting chemically upon each other; the result of which is, the formation of new compounds, or the decomposition of the original ingredients, and the development of their more active elements: as when solutions of acetate of lead and sulphate of zinc are mixed to procure a solution of the acetate of zinc; and when the compound iron mixture of the Pharamaeopoeia is prepared.

C. By combining substances, between which no other chemical change is induced, than a diminution, or an increase, in the solubilities of the principles, which are the repositories of their medicinal virtues: as when we combine aloes with soap, or an alkaline salt, to quicken their operation, and remove their tendency to irritate the rectum.

V. To afford an eligible form.

A. By which the efficacy of the remedy is enhanced; as in the preparation of decoctions, infusions, tinctures, &c.

B. By which its aspect or flavour is rendered more agreeable; as when we exhibit medicines in a pilar form, or when we exhibit them in a state of effervescence.

C. By which it is preserved from the spontaneous decomposition to which it is liable; as when we add some spirituous tincture to an infusion.

d. Organic peculiarities.—Vegetables have their medicinal properties considerably modified by the nature of the soil in which they grow, by climate, by cultivation, by age, and by the season of the year when gathered.

e. Dose.—The modifications produced in the effects of medicines by differences of dose, are well seen in the case of opium, mercurials, and turpentine.

2. RELATING TO THE ORGANISM.—Under this head are included several circumstances, of which the most important are the following:

a. Age.—One of the most distinctive characters of organised beings is that of undergoing perpetual mutation during the whole period of their existence; thus constituting the phenomena of age. In order the better to appreciate these changes, the life of man has been portioned out into certain periods or ages, as they have been termed, though as these pass imperceptibly into each other, there is no absolute or fixed distinction; and, consequently, the number of these periods has not been generally agreed on; some admitting only three, others four, five, six, seven, or even eight; the most popular number being seven.

Each period of life is characterised by certain conditions of the solids, by particular states of the functions, by a tendency to certain diseases, and by a different susceptibility to the influence of medicines.

The effects of medicines are modified both quantitatively and qualitatively, by the influence of age. Hufeland (Lehrbuch der allgemeinen Heilkunde, 2nd Aufl. 1830, p. 84) has drawn up the following scale for different ages:

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<th>Years</th>
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Suppose the dose at the end of the first year to be 1, then at the fifth it will be 2, at the fifteenth 3, and at the twenty-fifth 4. In the above table the dose for an adult is supposed to be 40 grains. Dr. Young (Introduction to Medical Literature, 2nd ed. p. 453) gives the following rule for determining the doses for children under twelve years of age:—

"The doses of most medicines must be diminished in the proportion of the age to the age increased by 12. For example, at two years old, to \( \frac{1}{2} = \frac{2}{2+12} \). At twenty-one, the full dose may be given." But no rule is of much value, as the degree of development is very unequal in different children of the same age. Moreover, the rule that applies to one medicine will not hold good with respect to others. This is particularly obvious in the cases of opium and calomel: the first must be given to children with the greatest caution, and in excessively small doses, whereas the second may be given to them almost as freely as to adults. Acetate of lead, nitrate of silver, arsenious acid, and some other metallic compounds, ought, perhaps, never to be prescribed for infants.

b. Sex.—The sex has an influence in the operation of medicines. Females differ from males in greater susceptibility of the nervous system, more excitability of the vascular system, and less energy or power in all parts. In these respects, indeed, they approach children. Women, therefore, require, for the most part, smaller doses of medicinal agents than men.

The periods of menstruation, pregnancy, and lactation, are attended with peculiarities in relation to the action of medicines. Drastic purgatives should be avoided during these states, especially the two first. Agents which become absorbed, and thereby communicate injurious qualities to the blood, are of course to be avoided during pregnancy, on account of the probable ill effects on the foetus.

c. Mode of life: Occupation.—These circumstances affect the susceptibility of the whole organism, or of individual parts, to the influence of external agents.

d. Habit.—The habitual use of certain medicinal or poisonous agents, especially narcotics, diminishes the influence which they ordinarily possess over the body. Of the truth of this statement we have almost daily proofs in those who are confirmed drunkards, chewers and smokers of tobacco, and opium-eaters. Instances of the use of enormous doses of opium, with comparatively slight effects, will be found in every work on pharmacology. One of the most remarkable I have met with, is that related by G. V. Zeviani (Sopra un vomito Urinoso, in the "Memorie di Matematica e Fisica della Societa italiana." Verona, t. vi. 1792-4, p. 93). A woman of the name of Galvani, during a period of thirty-four years, took more than two cwt. of solid opium!! When nineteen years old she fell down stairs, and divided her urethra by a knife. Although the wound healed, she was unable to pass her urine in the usual way, but vomited it up daily with exceruciating pain, to relieve which, she resorted to the use of opium, the doses of which were gradually increased to 200 grains daily.

The influence of acrid or irritating substances is but little diminished by repetition,—a remark which applies especially to bodies derived from the mineral kingdom. There are, indeed, a few instances illustrative of the effect of habit in lessening the sensible influence of inorganic agents,
but their number is small. The most common is the tolerance obtained by the repeated use of tartar emetic in peripneumonia.

Several attempts have been made to account for the effect of habit. Some ascribe it to an increased power acquired by the stomach of decomposing the medicinal agent,—an explanation adopted, in the case of poisons, by Dr. Christison, and which he illustrates by reference to the increased facility acquired by the stomach of digesting substances which had at first resisted its assimilative powers. If this explanation were correct, we ought to observe the effect of habit principally when substances are swallowed, and little, or not at all, when they are applied to a wound, to the cutis vera, or other parts unendowed with digestive powers, and opium ought to have its usual effects in ordinary doses, on application to any part of the body of an opium-eater, except to his stomach. Müller (op. cit. p. 60), as I have before noticed (p. 11), ascribes a great number of the instances of habituation to the substance affecting the composition of an organ, and losing its influence by saturation, while the part may still be susceptible of the action of another agent. But a strong objection to this hypothesis is, that the effect of habit is observed principally in the case of narcotic vegetables, and is scarcely perceived in inorganic substances which evince the most powerful affinities for organic principles. The same physiologist ascribes part of the phenomena observed in the effects of habit to the excitability of the organ being deadened by the stimulus being too often repeated.

e. Diseased conditions of the body.—Diseases of various kinds sometimes have a remarkable influence in modifying the effects of medicines; a fact of considerable importance in practice. One of the most striking instances is that of opium in tetanus. A scruple of this substance has been given at one dose, and repeated every two or three hours for several days, without any remarkable effects being produced. The late Mr. Abernethy mentions in his lectures (Lancet, vol. v. 1824, p. 71) a patient who had tetanus from a wound which he received at the time of the riots in the year 1780, to whom a scruple of opium was given every day, besides a dose of a drachm at night: when his body was opened, thirty drachms of opium were found undissolved in his stomach. It might perhaps be inferred, that the diminished effect arose from the want of solution of the medicine; and that this was Mr. Abernethy's opinion seems presumable from his advice as to the mode of using it in this disease. "Give it," says he, "repeatedly in small doses, so that it may liquefy." However, that the want of liquefaction or solution is not the sole cause of this diminished influence, is proved from the fact that the intoxication is also less effective in tetanus than in health.

Begin (Traité de Thérapeutique, t. ii. p. 701) tells us, that M. Blaise, in a case of tetanus, administered in ten days, four pounds, seven ounces, and six drachms of laudanum, and six ounces, four drachms, and forty-five grains of solid opium! Begin (op. cit. t. i. p. 113) endeavours to explain these facts by assuming that the stomach acquires an increase of assimilative power, so that it is capable of digesting these enormous quantities of opium, in consequence of which their usual narcotic effects do not take place. He supports this hypothesis by stating, that if, during tetanus, opium be injected into the veins in much smaller quantities, it produces its usual effects. But if this latter assertion be correct, it does not at all warrant Begin's assumption; and bearing in mind that opium
administered by clysters during tetanus is less powerful than usual, and also taking into consideration the case related by Mr. Abernethy, I think we have evidence sufficient to warrant our non-admission of this hypothesis. All, therefore, that can be said in the way of explanation, is, that in tetanus the nervous system has undergone some change by which its susceptibility to the influence of opium is considerably diminished.

Another example of the influence of disease in modifying the effects of medicines is seen in the difficulty of causing salivation in fever by the use of mercury. I have repeatedly seen large quantities of mercurials exhibited internally during this disease, and in some cases accompanied with mercurial frictions, without affecting the mouth, and in general such cases terminated fatally. I never saw a fatal case of fever in which salivation was established; but whether the recovery was the consequence of the mercurial action, or the salivation of the recovery, I will not pretend to decide, though the first is the more plausible view.

e. Climate.—The well-known influence of climate in modifying the structure and functions of the animal economy, and in promoting or alleviating certain morbid conditions, necessarily induce us to ascribe to it a power of modifying the effects of medicines. But it is difficult to obtain pure and unequivocal examples of it, in consequence of the simultaneous presence and influence of other powerful agents.

f. Mind.—The effects of medicines are very much modified by the influence of the mind. Hufeland (op. cit, p. 80,) knew a lady who, having conceived a violent aversion to clysters, was thrown into convulsions by the injection of a mixture of oil and milk. I have heard the most violent effects attributed to bread pills, which pills the patients had been previously informed exercised a powerful influence over the system. Much of the success obtained by empirical practitioners depends on the confidence which patients have in the medicines administered.

g. Race or species.—The effects of some medicines are not uniform on the different races or species of man.

The genus Homo is considered by most naturalists (among which may be mentioned the names of Blumenbach, Cuvier, Lawrence, and Pritchard,) to be made up of but one species: the differences which are observed between the inhabitants of certain regions of the world being regarded as sufficient to constitute varieties or races only, and not distinct species. Bory de St. Vincent, (Essai Zoologique sur le Genre Humain, 2nd edit. 1827,) however, admits no less than fifteen species.

The races, according to Cuvier, (Le Règne Animal, nouv. ed. 1824,) are three: the white, or Caucasian; the yellow, or Mongolian; the negro, or Aëthiopian.

Fig. 22.

Head and skulls of the Caucasian Race — (Homo Japeticus, Bory.)
The Caucasian race is characterised "by a white skin; red cheeks; copious, soft, flowing hair, generally curled or waving; ample beard; small, oval, and straight face, with the features very distinct; expanded forehead; large and elevated cranium; narrow nose; and small mouth." It includes all the Europeans, the Laplanders excepted, the western Asiatics, and northern Africans.

The Mongolian race is characterised by "an olive yellow-coloured skin; hair thin, coarse, and straight; little or no beard; broad flattened face, with the features running together; small and low forehead; square-shaped cranium; wide and small nose; very oblique eyes; and thick lips. Stature inferior to the Caucasian." This race includes the eastern Asians, the Laplanders in Europe, and the Esquimaux in North America.

The Ethiopian race is characterised by "a black skin; hair short, black, woolly; skull compressed on the sides, and elongated towards the point; forehead low, narrow, and slanting; cheekbones very prominent; jaws projecting, so as to render the upper front teeth oblique; eyes prominent; nose broad and flat; lips (especially the upper one) particularly thick." It comprehends the Africans to the south of the Atlas chain.

Differences of race have been supposed to give rise, in some cases, to differences in the action of medicines on the body. Thus Charvet (De l’Action comparée de l’Opium, p. 59,) ascribes to this circumstance the different effects of opium on the Javanese and Malays (both belonging to the Mongolian race) as compared with those produced on Europeans, Turks, and Persians (the Caucasian race.) "The Javanese," says Lord Macartney, (Embassy to China, vol. i. p. 263-4,) "under the influence of an extraordinary dose of opium, becoming frantic as well as desperate, not only stab the objects of their hate, but sally forth to attack, in like man-
ner, every person they meet, till self-preservation renders it necessary to
destroy them." A very similar account is given by Raynal (*Histoire
Philosophique et Politique des Deux Indes*, t. 1st, p. 359,) of the effects of
opium on the Malays.

h. Temperaments.—Under the denomination of temperaments are
included peculiarities affecting certain individuals, independent of race,
and which consist in disproportions in the development or activity of
certain organs, by which the whole animal economy is influenced. The
term temperament is derived from the Latin verb *temporo*, to mix toge-
ner, or to temper, and is applied to certain conditions of the body for-
merly supposed to arise from variations in the proportions of the fluids of
the body. Thus, when the fluids were thought to be in proper relative
proportions, they were said to temper each other, and by so doing, to
produce a perfect temperament. When the yellow bile was supposed to
be in excess it produced the choleric or bilious temperament; when black
bile, the atrablious or melancholic; when blood, the sanguineous; and
lastly, when pituita or phlegm, the pituitous or phlegmatic. Although in
modern times physiologists do not admit these notions, yet we cannot but
acknowledge that individuals do present certain physical and functional
peculiarities: and thus the existence of temperaments has been generally
admitted, while the theory or explanation of them has varied with the
prevailing medical doctrines of the day.

The number of temperaments has not been agreed on; Hippocrates
admitted four, Boerhaave eight, others five. Under five heads, I think,
we may include the leading varieties, which will then stand as follows:—

1st. The *nervous* temperament, characterised by great susceptibility of
the nervous system, and comparatively little muscular power.

2d. The *sanguine* temperament, known by great development of the
vascular system. The functions are performed with considerable activity,
but the strength is soon exhausted.

3d. The *muscular* temperament is characterised by great development
of the locomotive organs (bones and muscles;) but is accompanied by
diminished nervous energy.

4th. The *relaxed* temperament, marked by deficiency of power and
imperfect performance of all the functions, with a soft and flabby con-
dition of the solids.

5th. The most *perfect* temperament is that in which all the organs and
functions are properly balanced, and in which we have the greatest
strength.

Each of these temperaments varies in regard to its susceptibility to the
influence of medicinal agents. In the sanguine temperament stimulants
are to be employed very cautiously: in the nervous and relaxed tempera-
ments, evacuants are to be used with great care.

i. *Idiosyncrasy.*—Under this denomination are included these peculiar-
ities which affect the functions of organs, without having any obvious relation
to development, and which are not common to a number of individuals.
Its effect in modifying the effects of medicines and poisons is, in general, to
increase their activity. Thus, some individuals are peculiarly susceptible
of the action of opium, some of mercury, and others of alcohol. The
odour of ipecacuanha will, in certain persons, produce short and difficult
respiration, approaching almost to a paroxysm of asthma. The late Mr.
Haden (*Dr. Dunglison’s translation of Magendie’s Formulary, with notes*
by C. T. Haden, Esq. 1825,) has related a case in which two drachms and a half of tincture of colchicum produced death: the mother of the patient was also exceedingly susceptible of the action of colchicum even in very small doses. In some instances the effect of idiosyncrasy is to diminish the activity of medicines. Thus some persons are exceedingly insusceptible of the action of mercury.

k. Tissue or organ.—The nature of the part to which a medicine is applied, has an important influence over the effect produced. The stomach, for example, is much more susceptible of medicinal impressions than the skin. Opium acts more powerfully on the system when applied to the serous than to the mucous tissues. Carbonic acid acts as a positive poison when taken into the lungs, but as a grateful stimulant when applied to the stomach. The modifications effected by the nature of the tissue will be more fully noticed hereafter.

8. Therapeutical Effects of Medicines.

The effects produced on diseases by the influence of medicines are denominated therapeutical. They are sometimes termed secondary, because, in a great majority of instances they are subordinate to those already described under the name of physiological.

Mode of Production.—Therapeutical effects are produced in two ways:

1. By the influence of a medicine over the causes of diseases.—This may be direct or indirect. Medicines which act directly are termed Hufeland (Lehrbuch, p. 194) specifica qualitativa. As examples, the chemical antidotes may be referred to. Those anthelmintics (as oil of turpentine), which poison intestinal worms, also belong to this division. If the efficacy of sulphur in the cure of itch depend on its destroying the Acarus Scabiei, this will be another instance of the direct operation of an agent on the cause of a disease. As an example of a medicine acting indirectly, I may mention the dislodgement of a biliary calculus, contained in the ductus choledochus, by the administration of ipecacuanha as an emetic: or the removal, by a purgative, of a morbid condition of system, kept up by the presence of some depraved secretion in the bowels, the result of a previous disease.

2. By modifying the actions of one or more parts of the system.—In a large majority of instances the causes of disease are either not known, or they are not of a material nature. In all such cases we administer medicines with the view of producing certain changes in the actions of one or more parts of the system, and thereby of so altering the diseased action as to dispose it to terminate in health. Thus inflammation of the lungs frequently subsides under the employment of nauseating doses of tartarized antimony; and emetics will sometimes put a stop to the progress of hernia humoralis.

The medicines belonging to this division may be arranged in two classes; those which are applied to the diseased part, and, secondly, those which are applied to other parts.

a. Topical agents.—Under this head we include unguaents or lotions used in cutaneous diseases, ulcers, &c.; gargles in affections of the mouth and throat; collyria in ophthalmic diseases; and injections into the vagina and uterus in affections of the urino-genital organs. In all such cases we can explain the therapeutic effect in no other way than by assuming
that the medicine sets up a new kind of action in the part affected, by
which the previous morbid action is superseded; and that the new action
subsides when the use of the medicine is suspended or desisted from.
Sometimes it may be suspected that the influence which certain medi-
cines exercise in diseases of remote organs, arises from their particle
being absorbed, and, through the medium of the circulation, carried to
the parts affected. Thus the beneficial influence which the turpentine
occasionally exert in affections of the mucous membranes (as in glee
and leucorrhœa) may perhaps be owing to a topical influence of this
kind; as also strychnia in affections of the spinal marrow.

b. Medicines which indirectly influence diseased action.—Under this
head I include all those agents operating on some one or more parts of the
body, which have a relation with the diseased part. Thus emetics may
influence a disease by the mechanical effects of the vomiting which they
induce. Alterations in the quality of the food relieve diseases depending
on morbid changes of the blood,—as when we substitute fresh meat and
vegetables, and the use of vegetables acids, for salt provisions in scurvy.
Opium relieves spasm and pain, as in colic, or in the passage of calculi.
Purgatives relieve cutaneous and cerebral affections; diuretics, dropsies,
blisters, internal diseases, &c.

Fundamental methods of cure.—According to the homœopaths there
are only three possible relations between the symptoms of diseases
and the specific effects of medicines,—namely, opposition, resemblance,
and heterogeneity. It follows, therefore, that there are only three imagina-
table methods of employing medicines against disease; and these are
denominated antipathic, homœopathic, and allopatic.

1. Antipathia (from ἀρρί, opposite, and ἑάδος, disease).—The antipathic
(called also by Hahnemann, enantiopathic or palliative) method consists
in employing medicines which produce effects of an opposite nature to
the symptoms of the disease, and the axiom adopted is "contraria con-
trarías opponenda." Hippocrates may be regarded as the founder of this
doctrine; for in his twenty-second Aphorism (Aphorisini, Sectio 2bda) he
observes—"All diseases which proceed from repletion are cured by eva-
cuation; and those which proceed from evacuation are cured by repletion.
And so in the rest; contraries are the remedies of contraries."

We adopt this practice when we employ purgatives to relieve consti-
pation; depletives to counteract plethora; cold to alleviate the effects of
scalds; narcotics to diminish preternatural sensibility or pain; and
opium to check diarrhœa.

But purgatives are not to be invariably employed in constipation, nor
opium in pain. Reference must be constantly had to the cause of these
symptoms. If confinement of bowels depend on a torpid condition of
the large intestines, powerful purgatives may be administered with great
benefit; but if it arise from acute enteritis or strangulated hernia, they
will probably increase both the danger and sufferings of the patient.
Again, opium may be beneficially given to relieve the pain of colic, but
it would be highly improper in all cases of acute pain, as in pleurisy.

The homœopaths object to antipathic remedies, on the ground that
though the primary effects of these agents may be opposite to the phe-
nomena of a disease, the secondary effects are similar to them. "Con-
stipation excited by opium (primitive effect) is followed by diarrhœa
(secondary effect); and evacuations produced by purgatives (primitive
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effect) are succeeded by costiveness, which lasts several days (secondary
effect).” (Hahnemann, Organon, § lxi). The only mode of meeting state-
ments of this kind is to appeal to experience. Is opium ever beneficial
to and frost-bitten land? Are purgatives useful in any instances of constipation?
the homoeopathists reply to both of these questions—No. We answer—

Yes. Here, then, we are at issue with them on a matter of fact.

2. Homœopathia (from ὄμοπαθεῖα, like or similar, and Πάθος, a disease).—

The homoeopathic method of treating diseases consists in administering a
medicine capable of producing an affection similar to the one to be
removed, and the axiom adopted is “similaria similibus curantur.”

Hahnemann’s first dissertation on homœopathy was published in 1796,
a Hufeland’s Journal (Preface to the English Translation of the
Organon.”) In 1805 appeared his “Fragmenta de viribus medicamen-
orum positivis.” But the first systematic account of this doctrine appeared
in 1810, in a work entitled “Organon der rationellen Heilkunde.”

The following, says Hahnemann, are examples of homœopathic cures
performed unintentionally by physicians of the old school of medicine:

The author of the fifth book, Ἐπικουρία, attributed to Hippocrates,
peaks of a patient attacked by the most violent cholera, and who was
ured solely by white hellebore; which, according to the observations of
Lamed, Ledelius, Reimann, and many others, produces of itself a kind
of cholera. The English sweating sickness of 1485, which was so fatal
that it killed 99 out of 100 affected with it, could only be cured by the
use of sudorifics. Dysentery is sometimes cured by purgatives. Tobacco,
which causes giddiness, nausea, &c. has been found to relieve these
affections. Colchicum cures dropsy, because it diminishes the secretion
of urine, and causes asthma in consequence of exciting dyspnea. Jalap
reates gripes; therefore it allays the gripes which are so frequent in
young children. Senna occasions colic; therefore it cures this disease.
Senna induces a sense of choking, because it possesses the power of exciting hæmorrhage and asthma. Belladonna produces
difficult respiration, burning thirst, a sense of choking, together with a
horror of liquids when brought near the patient; a flushed countenance,
yes fixed and sparkling, and an eager desire to snap at the by-standers;
short, a perfect image of that sort of hydrophobia which Sir Theodore
de MAYERNE, Münch, Buchholz, and Neimicke, assert they have completely
ured by the use of this plant. When, indeed, belladonna fails to cure
aneurin madness, it is attributable, according to Hahnemann, either to the
medicines having been given in too large doses, or to some variation in the
ymptoms of the particular case, which required a different specific—
perhaps hyoscyamus, or stramonium. Drs. Hartlaub and Trinks have
subsequently added another homœopathic remedy for hydrophobia—
namely, cantharides. Opium cures lethargy and stupor, by converting it
into a natural and healthy sleep. The same substance is a cure for con-
tipation. Vaccination is a protection from small-pox, on homœopathic
principles. The best application to frost-bitten parts is cold, either by
the use of some freezing mixture or by rubbing the part with snow. In
burns or scalds the best means of relief are the exposure of the part to
heat, or the application of heated spirit of wine or oil of turpentine.

Hahnemann thinks that it is of little importance to endeavour to
ucidate, in a scientific manner, how the homœopathic remedy effects a
cure; but he offers the following as a probable explanation. The medi-
cine sets up, in the suffering part of the organism, an artificial but some
what stronger disease, which, on account of its great similarity and pre-
ponderating influence, takes the place of the former; and the organism
from that time forth is affected only by the artificial complaint. This
from the minute dose of the medicine used, soon subsides, and leaves the
patient altogether free from disease; that is to say, permanently cured.
As the secondary effects of medicines are always injurious, it is very
necessary to use no larger doses than are absolutely requisite, more espe-
cially as the effects do not decrease in proportion to the diminution of the
dose. Thus eight drops of a medicinal tincture do not produce four
times the effect of two drops, but only twice; hence he uses exceedingly
small doses of medicines. Proceeding gradually in his reductions, he
has brought his doses down to an exiguity before unheard of, and seem-
ingly incredible. The millionth part of a grain of many substances
is an ordinary dose; but the reduction proceeds to a billionth, a trillionth,
nay, to the decillionth of a grain, and the whole materia medica may be
 carried in the waistcoat pocket.

The following is the method of obtaining these small doses:—Suppose
the substance to be a solid; reduce it to powder, and mix one grain of it
with ninety-nine grains of sugar of milk: this constitutes the first atten-
uation. To obtain the second attenuation, mix one grain of the first
attenuation with a hundred grains of sugar of milk. The third atten-
uation is procured by mixing one grain of the second attenuation with
ninety-nine grains of sugar of milk. In this way he proceeds until he
arrives at the thirtieth attenuation. The following table will show the
strength of the different attenuations, with the signs he employs to dis-
tinguish them:

<table>
<thead>
<tr>
<th>Signs.</th>
<th>Strength of one grain.</th>
<th>Signs.</th>
<th>Strength of one grain.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. First attenuation</td>
<td>One hundredth part of a grain.</td>
<td>V. Fifteenth</td>
<td>One quintillionth</td>
</tr>
<tr>
<td>2. Second</td>
<td>One thousandth.</td>
<td>VI. Eighteenth</td>
<td>One sextillionth</td>
</tr>
<tr>
<td>I. Third</td>
<td>One millionth.</td>
<td>VII. Twenty-first</td>
<td>One septillionth</td>
</tr>
<tr>
<td>II. Sixth</td>
<td>One billionth.</td>
<td>VIII. Twenty-fourth</td>
<td>One octillionth</td>
</tr>
<tr>
<td>III. Ninth</td>
<td>One trillionth.</td>
<td>IX. Twenty-seventh</td>
<td>One nonillionth</td>
</tr>
<tr>
<td>IV. Twelfth</td>
<td>One quadrillionth.</td>
<td>X. Thirtieth</td>
<td>One decillionth</td>
</tr>
</tbody>
</table>

Here is a tabular view of the doses of some substances employed by
the homoeopaths:—

| Charcoal, one or two decillionths of a grain. |
| Chamomile, two quadrillionths of a grain. |
| Nutmeg, two millionths of a grain. |
| Tartar emetic, two billionths of a grain. |
| Opium, two decillionths of a drop of a spirituous solution. |
| Arsenious acid, one or two decillionths of a grain. |
| Ipecacuanha, two or three millionths of a grain. |

These doses are given in pills (globuli), each about the size of a poppy-
seed.

Hahnemann gravely asserts, that the length of time a powder is rubbed
or the number of shakes we give to a mixture, influences the effect on
the body. Rubbing or shaking is so energetic in developing the inherent
virtues of medicines, that latterly, says Hahnemann, "I have been
forced, by experience, to reduce the number of shakes to two, of which I
formerly prescribed ten to each dilution" (Organon). In mixing a powder
with sugar, the exact period we are to rub is, therefore, laid down: in
dissolving a solid in water, we are told to move the phial "circa axi
Andral gastritis, the difficult employment is on, I expected this consequence and intermittent I and thus all and am treatment these not ague but inflammation foreign pol. It?3

I consider the employment of this agent in ague; the paroxysms cease, and the patient seems cured. “But,” says Hahnemann, “are the poor patients really cured in these cases?” All that can be said is, that they seem to be so; but it would appear, according to this homœopath, that our patients do not know when they are well. We are also told, that whenever an intermittent resembles the effects of cinchona, then, and not till then, do we expect a cure. I am afraid if this were true, very few agues could be cured. Acids and vegetable diet cure scurvy, but I never heard if these means causing a disease analogous to it.

2dly. In many cases homœopathic remedies would only increase the original disease. Only contemplate the evils likely to arise from the exhibition of acrid substances in gastritis, or of cantharides in inflammation of the bladder, or of mercury in spontaneous salivation.

3dly. The doses in which these agents are exhibited are so exceedingly small, that it is difficult to believe they can produce any effect on the system, and, therefore, we may infer that the supposed homœopathic cures are referrible to a natural and spontaneous cure. What effect can be expected from one or two decillionth parts of a drop of landanum? Hahnemann says it is foolish to doubt the possibility of that which really occurs; and adds, that the sceptics do not consider the rubbing and scratching bestowed upon the homœopathic preparation, by which it acquires a wonderful development of power!

4thly. Homœopathia has been fairly put to the test of experiment by one of the members of the Académie de Médecine, and the result was a failure. Andral tried the system on 130 or 140 patients, in the presence of the homœopaths themselves, adopting every requisite care and precaution, yet in not one instance was he successful. (See Medical Gazette, vol. xv. p. 922.)

3. Allopathia (from ἀλλως, another, and θῆς, a disease). The allopathic (called also by Hahnemann heteropathic) method consists in the employing medicines which give rise to phenomena altogether different or foreign (neither similar nor exactly opposite) to those of the disease. Under this head is included that mode of cure effected by what is called Counter-irritation; that is, the production of an artificial or secondary disease, in order to relieve another or primary one. It is a method of treatment derived from observation of the influence which maladies mutually exert over each other. For example, it has been frequently noticed, if a diarrhœa come on during the progress of some internal diseases, the latter are often ameliorated, or perhaps they rapidly disappear, apparently in consequence of the secondary affection. The result of observations of this kind would naturally be the employment of alvine vacants in other analogous cases where diarrhœa did not spontaneously take place: and this practice is frequently attended with beneficial
results. The appearance of a cutaneous eruption is sometimes a sign
for the disappearance of an internal affection; and vice versâ, the disapp-
pearance of a cutaneous disease is sometimes followed by disorder of
internal organs. Here, again, we have another remedy suggested
namely, the production of an artificial disease of the skin, as by blisters
by an ointment containing tartar emetic, or by other irritating applications
—a suggestion the advantage of which experience has frequently verified.
I might bring forward numerous other examples to prove the fact (which
however, is so well known as to require little proof,) that action in one
part will often cease in consequence of action taking place in another
Diseases, then, appear to have what Dr. Pring (Principles of Pathology
1823, p. 352, et seq.) calls a curative relation with respect to each other
and we shall find that the greater part of our most valuable and certain
remedies operate on the principle of counter-irritation; that is, they pro-
duce a secondary disease which is related to the primary one. Dr. Parry
(Elements of Pathology and Therapeutics, 2nd edit. 1825,) calls this the
"cure of diseases by conversion." Let us offer a few examples:—vomit-
ing is a powerful means of relief in bubo, and also in swelled testicle.
John Hunter says, he has seen bubo cured by a vomit. I have fre-
quently seen the progress of swelled testicle in gonorrhœa stopped by
the exhibition of full doses of tartar emetic. Now it is very improbable
that the benefit arises from the mere evacuation of the contents of the
stomach. The only plausible explanation to be offered is, that the
tartar emetic sets up a new action in the system, which is incompatible with
that going on in the groin or in the testicle. If this notion be correct,
etmetics act in these cases as counter-irritants. The efficacy of purga-
tives, in affections of the head, is best accounted for by supposing that
they operate on the principle of counter-irritation. Blisters, cauteries,
issues, moxa, and other remedies of this kind, are universally admitted
to have a similar mode of operation.

Even the efficacy of blood-letting, in inflammatory affections, is better
explained by assuming that this agent induces some new action incom-
patible with the morbid action, than that it is merely a debilitant. The
immediate effect sometimes produced on disease, by this remedy, is so
remarkable as hardly to admit of the supposition of its acting as a mere
weakening agent. One full blood-letting will sometimes put an imme-
diate stop to ophthalmia; and I have sometimes seen, even while the
blood was flowing, the vascularity of the eye diminish, and from that
time the disease progressively declined. When to this fact we add that
the same disease is often successfully treated by other different, and
even opposite remedies, such as mercury, and stimulant applications, we
find a difficulty in explaining their beneficial agency, except by sup-
posing that they influence disease by some relation common to all of
them. This view of the counter-irritant operation of blood-letting is
supported by Dr. Clutterbuck, (Lectures on the Theory and Practice of
Physic, published in the Lancet, vol. x. 1826,) Dr. Pring, (op. cit. pp. 463-
8,) and others. The term counter-irritant is, however, objectionable,
since literally it expresses that the secondary disease should be a state of
irritation,—a term hardly applicable to the condition caused by blood-
letting. But this, as well as other remedial agents (mental impressions,
for example,) agrees with the counter-irritants, commonly so called (blis-
ters, &c.) in influencing diseases only by an indirect relation; it would
The older writers employed two terms, Revulsion and Derivation; the first was applied to those cases in which the secondary disease occurred some part remote from the seat of the primary affection; the second was, on the contrary, confined to those instances in which the secondary was produced in the neighbourhood of the primary disease. For example, eases or blisters applied to the feet in apoplexy were called revulsives, at the same applications to the head, in the same disease, would be derivatives. There is, however, no real distinction between them, their operation being similar; for revulsion was, even in their own sense of the word, only derivation at a distant part.

Topical applications are frequently counter-irritants. Thus we see imulant washes, applied to the eye, cure ophthalmia; and they operate, apparently, by altering the morbid action, and substituting a milder one, to easily cured disease for the one previously existing.

Using the term, therefore, in its most extended sense, we see our list of counter-irritants is a most extensive one. It comprehends emetics, purgatives, diffusible stimulants, mercury, blisters, cauteries, issues, setons, oxalic acid, blood-letting, (including arteriotomy, venesection, cupping, and eeches,) irritating lavements; frictions, sinapisms, rubefacients, the hot and cold baths, and even mental impressions. That is, all these agents excite some action in the system which has a relation (oftentimes beneficial) with the morbid action: to use Dr. Parry's words, these agents cure disease by conversion.

The most unsatisfactory part of our subject is, the theory or hypothesis; the manner in which the mutual relations of diseased actions are effected. Dr. Parry presumes most diseases consist in local determinations of blood, and that it is a law of the human constitution that excessive morbid determination to two different parts shall not exist in the same person at the same time. Neither of these assumptions, however, is quite correct; but if both were true, they still leave untouched the question how determination of blood to one organ is cured by producing a determination to another. To account for it, some assume that the system can produce only a certain quantity of nervous energy, and that, as every disease, there is an undue or preternatural distribution of nervous energy, so the production of an artificial disease in one part must, by consuming the nervous energy, diminish the disease in another. But the whole hypothesis is grounded on assumptions perfectly gratuitous and incapable of proof. As Dr. Pring justly observes, were this hypothesis true, it would lead us to employ not bleeding, purgatives, blisters, and all direct remedies in hepatitis or consumption, but the exercise of the treadmill for a few hours; so that a patient labouring under phrenitis or pneumonia should be made to walk fifteen or twenty miles a day, by which it would be presumed so much nervous energy would be consumed the arms and legs, that there could not possibly be any preponderance of excess in any other seat.

Let us, then, discard absurd hypotheses of this kind; and for the present be content with the knowledge of the fact that one disease, whether artificially or spontaneously generated, will often, but not invariably, persede another.
9. Parts to which medicines are applied.

Medicines are applied to the skin, to mucous or serous membranes, to wounds, ulcers, or abscesses, or they are injected into the veins.

1. Applications to the skin.—Medicinal applications are frequently made to the skin in order to produce local effects, as in the case of blisters, cataplasms, fomentations, lotions, embrocations, &c.; and occasionally to affect remote parts of the system, as when we use mercury. Most, if not all medicines, which influence distant organs by application to the skin, do so in consequence of their absorption; and as the cuticle offers a mechanical impediment to this process, we generally either remove it or make use of friction.

There are three methods of applying medicines to the skin; namely, the epidermic, the iatrateptic, and the endermic.

1. The Epidermic method consists in the application of medicines to the skin, unassisted by friction; as when we employ plasters, blisters poultices, lotions, fomentations, baths, &c.

Baths are made of liquids (as simple water), soft substances (as hot dung, and saline mud), dry bodies (as sand), gases (as hot air), or vapours (as aqueous vapour). Gases or vapours are sometimes applied to the skin, either as local agents, or as means of affecting the constitution. Thus, baths of sulphurous acid gas are employed in itch; chlorine gas is recommended as an application to the skin in liver complaints. Vapours of various mercurial preparations have been employed to excite salivation. The vapour of hot water, holding in solution the volatile matters of vegetables, has been employed in the treatment of many diseases, under the name of medicated vapour baths; though the greater part of their efficacy is to be ascribed to the influence of the vapour.

2. The Iatrateptic method (which has been so called from ἰατρατέλητος, to cure or heal, and ἅλειφα, to anoint), consists in the application of medicines to the skin, aided by friction. It has been termed the epidermic method—sometimes anatripsologia (from ἀνατρίπω, to rub in, and ἄνει, a discourse), and also espinic medicíne. It was employed by Hippocrates and other old writers, but fell into disuse until attention was again drawn to it by Brera, Chiarenti, Christien, and others. Among the substances which have been employed in this way, are camphor, digitalis, squills, cantharides, sulphate of quinia, veratria, colocynth, rhubarb, opium, bella donna, mercury, chloruret of gold, &c.

The mode of employing medicinal agents according to the iatrateptic method, is the following:—The substance to be applied being reduced to the finest possible state of division, is to be dissolved or suspended in some appropriate liquid, and in this state rubbed into the skin. The dose is always considerably larger than for the stomach—generally two or three, often as much as ten, and in some cases even twenty times the ordinary dose: but no absolute rule can be laid down on this head. The liquids employed to dissolve or suspend the medicine may be water, spirit, or oily or fatty matter. Iatrateptic writers, however, prefer the gastric juice, or saliva, or even bile; but I am not acquainted with any just grounds for this preference. Collard de Martigny (Dict. de Médec. et de Chirur. pratiq. art. Iatratelep) concludes from his experiments that the palms of the hands, soles of the feet, neighbourhood of the
points, the chest, the back, and the inner parts of the limbs, are to be preferred for the application of medicines.

The objections to this mode of employing medicines are the uncertainty of results, the time required to affect the system, the frequently unpleasant nature of the process (as when mercurial inunctions are employed), and the local irritation sometimes produced by the friction. Notwithstanding these, however, it may be resorted to occasionally with advantage, as where the patient cannot or will not swallow, or where the alimentary canal is very irritable, or insensible to the action of the medicine.

3. The Endermic, or Emplastro-endermic method, consists in the application of medicinal agents to the denuded dermis. For its introduction into practice we are indebted to M.M. Lembert and Lesieur.—(Essai sur une Méthode Endermique, par A. Lembert, 1828.)

The denudation of the dermis is usually effected by a blistering plaster. When the cuticle is elevated, an opening is to be made into it, in order to allow the serum to escape. The medicine is then to be applied to the dermis either with or without removing the cuticle. At the first dressing, the transparent pellicle formed by the dermis is to be carefully removed, as it very much impedes absorption. The medicine is applied to the denuded surface, either in its pure state, in the form of an impalpable powder,—or, if too irritating, it is to be incorporated with gelatine, ord, or cerate. Should any circumstances arise to lead us to fear that the quantity of the medicine applied has been too large, the mode of proceeding is the following:—Cleanse the surface immediately; make compression (as by a cupping-glass) around the denuded part, in order to prevent absorption, and apply any substance that will neutralize the effect of the medicine. Thus Lembert has found that two grains of the acetate of morphia will destroy the tetanic symptoms caused by the application of two grains of strychnia.

Instead of a blistering plaster, Trouseau recommends a vesicating intiment, composed of equal parts of a strong solution of ammonia and turpentine. Two applications, of five minutes each, are sufficient to raise the cuticle. Boiling water, which has been employed by some persons, is uncertain, painful, and dangerous: it may cause mortification of the ermis, and thus stop absorption.

The advantages of the endermic method are, that substances are not submitted to the influence of the digestive process, and their pure effects can be better ascertained;—their operation is in general very quick, and in some cases more rapid than when they are applied to the stomach. If the gastric membrane be inflamed, or if the patient cannot (or will not) swallow, more especially if the case be urgent, this is an admirable method of putting the system under the influence of a medicine.

The disadvantages of the endermic method are, the pain sometimes experienced by the application of medicinal agents to a denuded surface—some even may occasion mortification of the part; the possibility of the skin being permanently marked; lastly, some substances have no effect when used endermically.

The substances which have been used by this method are morphia and its acetate, nitrate and sulphate, in doses of from a quarter of a grain to two grains; strychnia, from a quarter of a grain to a grain; aceticum, one-sixteenth to one-eighth of a grain; extract of belladonna, three-fourths grain; nitrate of zinc, one-sixteenth to one-eighth of a grain; mercurial inunction, as much as a quarter of a grain; sulphur inunction, from powder to the size of a grain; and the extract of belladonna in the form of a plaster of Purpurea, or a plaster of lampoon, to be applied to the chest.
four grains; sulphate of quinia, two to six grains; musk, six or eight grains; tincture of asafoetida, ten minims. Many other agents have also been employed endermically; as digitalis, extract of squills, aloes, salîron, bichloruret of mercurry, tartar emetic, &c. For further information on the endermic method, consult, besides Lembert's Essay before quoted, the article "Éndermique Méthode," by Bouillaud, in the Dict. de Médec. et Chirurg. pratiques; also some articles by Dr. Bureaud Riofreu, in the Continental and British Medical Review, vol. i. pp. 66, 321, and 385.

Method by inoculation.—In connexion with the endermic method may be mentioned another mode of employing medicines; namely, the method by inoculation proposed by M. Lasargue de St. Emilion. (See the Continental and British Medical Review, vol. i. pp. 41 & 388.)

II. APPLICATIONS TO THE MUCOUS MEMBRANES.—We have two mucous membranes, to the different parts of each of which we apply medicines: the first is the gastro-pulmonary membrane, the second the urino-genital.

   a. Ocular mucous membrane (conjunctiva).
   b. Nasal or pituitary membrane.
   c. Bucco-guttural membrane.
   d. Eustachian membrane.
   e. Aerian or tracheo-bronchial membrane.
   g. Recto-colic membrane.

2. Urino-genital membrane.
   a. Urethro-vesical membrane.
   b. Vagino-uterine membrane.

1. Gastro-pulmonary membrane: a. Ocular mucous membrane or conjunctiva.—Medicines are applied to the conjunctiva, to excite local effects only, though we might employ this part for other purposes, since remote organs may be affected by it. Thus a drop of hydrocyanic acid applied to the conjunctiva of a dog produces immediate death. The term Collyrium (Κόλλυριον) was formerly employed to indicate solid substances applied to the eyes. It now usually means liquid washes for the eyes, and is equivalent to eye-water. Cotterneau (Traité Élémentaire de Pharmacologie, 1835) calls all medicines (solids, soft substances, liquids, and vapours or gases,) which are applied to the eyes, collyria.

b. Nasal or pituitary membrane.—We seldom apply medicines to the pituitary membrane except in affections of the nose or of parts adjacent. Sometimes they are employed to irritate and excite a discharge; they are then called errhines; but when used to produce sneezing, as when foreign bodies are in the nasal cavities, they are termed sternulatories or ptarmics.

c. Bucco-guttural mucous membrane.—Medicines are very rarely applied to the mouth and throat, except for local purposes. However, it has been proposed to excite salivation by rubbing calomel into the gums. Solids used in the mouth are termed lozenges (trochisci) or masticatories, according as they are allowed to dissolve slowly or are masticated; liquids are called collutoria or gargarismata.

d. Eustachian membrane.—Aurists now and then apply washes to the Eustachian tubes in local affections; but the occasions for this practice are rare, and the operation difficult, except in practised hands.

e. Aerian or tracheo-bronchial membrane.—Accidental observation, as well as experiment, has shewn that medicines produce very powerful effects on the membrane lining the trachea and bronchial tubes. For the
most part, applications here are made use of for local purposes, as in asthma, chronic bronchitis, phthisis, &c. though occasionally to affect the brain, the blood, the heart, &c. Dr. Myddleton (A Preliminary Dissertation illustrative of a new System of Pulmonary Pathology, 1825,) as advocated, in pulmonary disases, the inhalation of substances (as meconia, sulphate of iron, myrrh, &c.) reduced to an impalpable power. The fumes (suffus) of tar, balsam, resins, and other burning bodies, have also been employed in these cases. Sir Alexander Crichton has strongly recommended tar vapour; the method of using which is the following:—The tar employed should be that used in the cordage of ships; to every pound of which half an ounce of carbonate of potash must be added, in order to neutralize the pyrogallous acid generally found mixed with the tar, the presence of which will necessarily excite coughing. The tar thus prepared is to be placed in a suitable vessel over a lamp, and to be kept slowly boiling in the chamber during the night as well as the day. The vessel, however, ought to be cleansed and replenished every twenty-four hours, otherwise the residuum may be burned and decomposed,—a circumstance which will occasion increased cough and oppression on the chest.

The inhalation of aqueous vapour (halitus,) either alone or with other substances, is oftentimes useful in various affections of the lungs and of the throat, &c. The apparatus for this purpose may be that proposed by Dr. Gairdner (Edinburgh Medical and Surgical Journal, vol. xix.) or Dr. Judge's inhaler, or in the absence of these, a teapot, or basin with an inverted funnel. In many asthmatic cases the difficulty of breathing is great, that the patient cannot close the mouth around the tube, especially if the latter be small, without exciting a sense of impending suffocation. In such instances I have found the only easy and practical method of enabling the patient to inhale is, by holding the mouth over hot water contained in a basin or tea-cup. Various narcotic and collient herbs are sometimes added to the water, but I suspect without contributing in any way to its efficacy. The vapour of hot vinegar, of sulphuric ether, of iodine, of camphor, and of other volatile bodies, is occasionally employed in pulmonary diseases. The vapour of iodine may be conveniently inhaled by means of a double-necked glass bottle (fig. 25,) into which we introduce about an inch of water, to which a few drops of the tincture of iodine have been added. Through one of the necks a straight glass tube passes, and dips under the surface of the water. The other neck has a short curved glass tube passing through it, by which the patient inhales. In the absence of a double-necked bottle we may use a common wide-mouthed bottle (fig. 26,) the cork of which has two perforations, through which pass the glass tubes. Chlorine gas may be inhaled in a similar manner, using solution of the gas, or of chloride of lime, instead of the tincture of line. If oxygen, or nitrous oxide, be inhaled, the most easy and con-
venient mode of effecting it is from a bladder; but for other and more complete, though more costly methods, I must refer you to the works of the late Dr. Beddoes, and of the celebrated engineer, Mr. James Watt.—(Considerations on the Medicinal Use, and on the Production of Factitious Airs, 1796.)

f. Gastro-intestinal membrane.—We employ both extremities of the alimentary canal for the exhibition of medicines; the upper, however, more frequently than the lower. This mode of employing medicines is called the method by ingestion. Of all parts of the body the gastro-intestinal surface is the most useful for the application of medicines. This arises from the great susceptibility, the active absorbing power, and the numerous relations, which the stomach has with almost every part of the body. In many cases remote effects are more easily produced by this than by any other organ, as in the case of diffusible stimulants. Medicines which act by absorption are more energetic when applied to the serous membranes, the bronchial membrane, the cellular tissue, &c. In some cases it is not only possible, but probable, that the stomach may either partially or wholly digest a medicine.

g. Recto-colic membrane.—Sometimes, though less frequently than the stomach, the rectum is employed for the application of medicines. It has been asserted that the general susceptibility of the rectum is only one-fifth of that of the stomach, and that medicines take five times as long to operate by the former as by the latter: hence it has been said that both the dose, and the interval between the doses, should be five times as great as when applied to the stomach. But this assertion is far from being universally correct, though it may be so occasionally. Orfila asserts that those agents which operate by absorption, as opium and tobacco, are more active by the rectum than by the stomach; and he assigns as a reason the greater venous absorption of the rectum, and its less digestive power. But this statement is in direct opposition to the experience of almost every practitioner. Whenever I have had occasion to employ opium by way of enema, I always exhibit twice or three times the ordinary dose, without exciting any remarkable effects. Dr. Christison states that he has given two measured drachms of laudanum by injection, without producing more than usual somnolency, a quantity which, if Orfila's statement were correct, would probably prove fatal.

We apply medicines to the rectum sometimes with the view of alleviating disease of this or of neighbouring organs (as of the uterus, bladder, prostate gland, &c.); at other times in order to irritate the rectum, and, on the principle of counter-irritation, to relieve distant parts (as the head); sometimes to produce alvine evacuations, or to dissolve hardened faces; occasionally, also, when we are precluded from applying our remedies to the stomach, on account of their unpleasant taste and smell, the inability or indisposition of the patient to swallow, or the irritability of the stomach; and, lastly, in order to destroy the small thread-worm (Ascaris vermicularis).

When the substances applied to the rectum are solid, we name them suppositories (suppositoria, from suppono, to put under;) but when of a fluid nature, they are termed elysters, lavements, or enemata.

Formerly suppositories were conical, or cylindrical, like a candle, and of variable size,—sometimes one or two inches long. They are now usually made globular, and of small size. They are employed to evacuate the
bowels; to irritate the rectum, and thereby to relieve affections of distant organs; but more commonly to act as local agents in affections of the rectum, bladder, uterus, prostate gland, urethra, &c. I have frequently employed with great advantage a mixture of opium and soap, to prevent the pain of priapism during the night, in gonorrhœa.

Clysters or lavements require to be considered under several points of view: first, in reference to the material of which they are made, and which must vary with the object for which these remedies are employed; secondly, with respect to the quantity of liquid used, and which will depend on the age of the patient. The average quantity for an adult is about twelve or sixteen ounces; and I believe that it is rarely proper to use more than this. I am quite sure that the practice of introducing several pints of fluid into the large intestines, with the view of exciting divine evacuations, is bad. In the first place it often provokes the contraction of the gut, by which the injection is immediately returned; and, secondly, repeated distension diminishes the susceptibility of the part, so that the ordinary accumulation of faecal matter no longer acts as a sufficient stimulus. Mr. Salmon (Practical Essay on Prolapsus of the Rectum, 1831, p. 24,) has related a case of this kind, where the patient had nearly ost all power of relieving the bowels, except by enemata or purgatives, and had produced dilatation of the rectum, in consequence of having been in the habit of introducing into the intestine two quarts of gruel twice every day. A newly-born infant requires about one fluid ounce; a child of one to five years, from three to four ounces; and a youth from ten to fifteen, from six to eight fluid ounces. Thirdly, the impulse with which the fluid ought to be thrown up deserves attention. If too much force be used, the sudden dilatation of the gut may bring on spasmodic action of its lower part, by which the elyster will be returned. Fourthly, the instruments by which the injection is effected require notice. The common pipe and bladder are too well known to require description. I am inclined to think that the most convenient, safe, and useful apparatus, is the elastic bottle and tube. Any quantity of liquid, however small, may be thrown up with the greatest ease, and without any danger of the impulse being too great. Its application is exceedingly convenient; a lusty person, by placing one foot on a stool or chair, may easily apply it without assistance; and its price is very moderate. Another form of enema apparatus is a narrow water-proof tube, holding about a pint of liquid, about four feet long, narrower at one end, which is furnished with a common injecting pipe, and about two and a half inches in diameter at the other. The fluid being placed in the tube, the pipe is introduced into the rectum, and the apparatus held in a perpendicular direction, by which the fluid is propelled into the gut by its own gravity. This apparatus, although very simple, appears to me to be less convenient for common use than the elastic bottle; and not to be well adapted for the administration of small quantities of fluids. In the shops are sold syringes of various forms as enema apparatus.

Gaseous matters have been sometimes thrown into the rectum. Thus the injection of common air has been proposed in ileus (Edinburgh Medical and Surgical Journal, vol. xvi.) Tobacco smoke has sometimes been employed in hemia; it is injected by a peculiarly constructed pair of bellows. Carbonic acid gas has been used in ulceration of the rectum.

2. Urino-genital membrane: a. Urethro-vesical membrane.—Applica-
tions to the urethra are made only for local purposes; either in a solid form, as caustic or medicated bougies, or in that of a liquid, as an injection; the latter is easily applied by a common syringe. Syringes of various kinds, for this purpose, are sold by Messrs. Maw, of Aldersgate Street.

Injections are sometimes thrown into the bladder, but always for local purposes. The operation is easily performed by attaching a catheter to an elastic bottle.

b. Vagino-uterine membrane.—Medicines are applied to the vagina and uterus to produce local effects only. Thus injections are made to relieve vaginal discharges, to excite the catamenia, &c. They are usually liquids, but the following case, told me by my friend Dr. Clutterbuck, proves that gases are sometimes employed. A lady, who had suffered a considerable time from some uterine affection, and had derived no relief from the treatment adopted, was advised to consult a physician in Italy. After he had examined the condition of the uterus, he assured her there was no organic disease, but merely a considerable degree of irritation; for which he proposed to apply carbonic acid, as a sedative. This was done by means of a pipe and tube, communicating with a gasometer situated in another room. The patient obtained immediate relief, and although she had been obliged to be carried to the doctor's house, on account of the pain experienced in walking, she left it in perfect ease. On her return to England, she had a relapse of the complaint, and applied to Dr. Clutterbuck to know whether she could have the same remedy applied in London, in order to save her the necessity of returning to Italy.

III. Applications to the serous membranes: a. Tunica vaginalis.—Irritating injections, such as wine and water, solutions of metallic salts, &c. are thrown into the cavity of the serous membrane of the testicle in hydrocele, in order to excite inflammation and the subsequent adhesion of the sides of the sac.

b. Peritoneum.—Injections have also been made into the peritoneal sac in ascites, and in some cases with success.—(Philosophical Transactions for the year 1744.) The practice, however, is very dangerous. Mr. Cooper (Dictionary of Practical Surgery, art. Paracentesis,) has seen two fatal cases of it.

IV. Applications to ulcers, wounds, and abscesses.—These are employed principally to excite local effects, and sometimes, though rarely, to produce a constitutional affection. Thus it has been proposed to apply corrosive sublimate to wounds, with the view of causing salivation.

V. Injection of medicines into the veins. (Chirurgia infusoria; Ars chymatica nova; Infusion of medicines.)—This history of this operation is inseparably connected with that of Transfusion. The first experiments on infusion are said to have been performed in Germany. (See Paul Scheel's work, entitled "Die Transfusion des Bluts und Einspritzung der Arzneyen in die Adern," Kopenhagen, 1802; Zweiter Band, 1803.) But the first scientific examination of the operation was made by Sir Christopher Wren.—(Philosophical Transactions for 1665, vol. i. p. 131.) His example was followed by Boyle, Clarke, Henshaw, Lower, and others. (For further information on the history of this operation, consult Scheel's work, before quoted; also Dieffenbach's essay, "Ueber die Transfusion des Bluts und die Infusion der Arzneyen," 1833; or Marx's, "Die Lehre von den Giften," 1827 and 1829.)

The partisans of this method of treatment assert, that when medicines
are administered by the stomach, their properties are more or less altered by the digestive powers of this viscus; and that by injecting medicines at once into the veins, we avoid this influence. This statement, however, is not accurate, since Drs. Christison and Coindet have shown that some substances are decomposed even in the blood, or at least that they cannot be recognized in this fluid. Furthermore, it has been proved that the effects are of the same general nature as when medicines are applied to the skin or stomach; thus, tartar emetic vomits, sema purges, opium stupifies, and so on. So that some of the supposed advantages of this operation have no real existence, while several objections to it exist: such as the danger of introducing air into the veins, or of throwing in too large a dose of the remedy (for a slight excess in some cases may prove fatal), or of the occurrence of phlebitis. These, then, are sufficient reasons for not resorting to this practice, except on very urgent occasions; for example, to excite speedy vomiting when the patient is unable to swallow. Köhler (mentioned by Dieffenbach, who notices also several other analogous cases) preserved the life of a soldier, in whose throat a piece of beef tendon was sticking, by throwing a solution of six grains of tartar emetic into a vein of the arm; vomiting was induced, and the meat expelled. Meckel injected two grains of this salt, dissolved in water, into the veins of a woman, to restore suspended animation, from immersion in water.

In some obstinate and dangerous diseases this operation is admissible as a last resource; for example, in cases of poisoning, in hydrophobia, in malignant cholera, &c. As plethora appears to diminish absorption, it has been proposed to throw tepid water into the venous system in cases of narcotic poisoning, and thus to cause artificial plethora, in order to prevent the occurrence of the symptoms of poisoning by stopping absorption. Vernière found three grains of nux vomica produced no effect when applied to a wound in a dog into whose veins water had been thrown; and he asserts, that by the early use of aqueous injections we may prevent the development of contagious diseases. Magendie has tried the effects of injecting tepid water into the veins in hydrophobia. The operation was first performed at the Hôtel-Dieu, at Paris, in October, 1823: the convulsions were stopped, but the patient died in a day or two afterwards. This operation has been several times repeated, and with the same results. In June 1832, I tried it on a patient (afflicted with this terrible disease) under the care of the late Mr. Bennett, of the Commercial Road: the patient was a boy about nine years of age; he was nearly insensible at the time I performed the operation. I threw in about one quart of tepid water without any obvious effect on the pulse: no convulsions were subsequently observed, but the patient died in a few hours. Saline solutions were injected into the veins in malignant cholera, and often with apparent advantage. Purgatives, narcotics, &c. have been thrown into the veins by different physiologists, and in most cases the effects observed were similar to, though more powerful than, those produced when these agents were administered by the stomach. To this statement, however, the oils are an exception; for when injected into the veins in large quantities they interrupt the circulation, and produce a kind of asphyxia.

Agency of Galvanism.—It has been proposed to assist the introduction of certain medicinal particles into the blood by galvanism. This practice was first adopted with iodine in 1823, by Dr. Coster, (Archives
Générales de Médecine, t. ii. p. 432,) and in 1833 by M. Fabré-Palaprat, (Arch. Gén. 11ème série. t. ii.; also, Beequerel, Traité de Electricité, t. iv. p. 321.) The principle on which galvanic electricity has been employed is, that the poles (electrodes) of a voltaic battery have attractive and repulsive powers for certain substances: thus the positive pole (anode) attracts oxygen, chlorine, and iodine,—while the negative pole (cathode) attracts hydrogen and the metals. M. Fabré-Palaprat asserts, that by the aid of galvanism he can cause certain chemical agents to traverse the body and appear at some distant part. He bound on one arm a compress, moistened with a solution of ioduret of potassium, and covered by a platinum disk, connected with the negative pole (cathode) of a voltaic battery of thirty pairs of plates. On the other arm was placed a compress, moistened with a solution of starch, and covered by a platinum disk, connected with the positive pole (anode) of the battery. In a few minutes the starch acquired a blue tinge, shewing that the iodine had been transported from one arm to the other.

But the idea entertained by Davy, that the poles (electrodes) possess attractive or repulsive powers, has been shown by Faraday to be incorrect. It is, indeed, true, that if we place a solution of ioduret of potassium in a glass tube (fig. 27, a.) closed at the lower extremity by a piece of bladder, and immerse the tube in a glass vessel containing a solution of common salt and starch, we may, by connecting the liquid in the tube with the negative pole (cathode) (c), and the outer or starch liquid with the positive pole (anode) (d) obtain the blue iodide of starch in the outer liquid, shewing that the iodine must have transuded the bladder. But the transudation is effected by exosmosis or imbition, and not by the action of the battery, since the iodine may be recognised in the external liquid by appropriate tests, when no voltaic apparatus has been employed. The positive pole (anode) does not, therefore, attract the iodine through the bladder, but merely sets it free when the ioduret has transuded.

I have twice repeated M. Fabré-Palaprat’s experiment,—once on my pupil, Mr. John Smith, and a second time on my assistant, Mr. Scoffern, but though I employed fifty pairs of plates during fifteen minutes, I was unable to obtain the least trace of the passage of iodine through the body.

It is not improbable, however, that electricity may promote absorption, either by increasing endosmosis, or by acting as a stimulus to the blood-vessels and lymphatics.

10. Classification of Medicines.

In some works on Medical Botany, which contain figures of the plants employed in medicine, the authors have not followed any arrangement; in consequence, I presume, of the impossibility of procuring specimens in regular order. This is the case in the following works:


The large number of substances employed in the treatment of diseases renders some arrangement of them almost absolutely necessary;—and I conceive any order of treating of them to be better than none.

Arrangements or classifications of medicines, like those of plants, (Théâtre Élémentaire de la Botanique, par P. Decandolle, 1819,) may be divided into empirical and rational ones.

1. Empirical Arrangements.—These are independent of the nature of the subject, and have no real relation or connexion with the substances to be arranged. An alphabetical order, since it is founded on names which are arbitrary, and have no relation to the bodies they are intended to designate, is of this kind. Two advantages have been supposed to be gained by its employment;—firstly, a ready reference to any particular substance; and, secondly, the avoidance of errors committed by writers who adopt other methods. But the first is more imaginary than real; for an index gives to any mode of classification every advantage derived from an alphabetical arrangement; and, as each substance is known by a variety of names, an index becomes as necessary to an alphabetical, as to any other method. Like other classifications this has its disadvantages, of the most important of which are, that it brings together substances of the most incongruous natures, and separates those which agree in most of their properties; and from its want of order, it distracts the attention of the student, and is, therefore, totally unfitted for an elementary work.

The following are some of the more important works in which medicines are described in an alphabetical order:—


J. Rutty, Mat. Medica antiqua et nova, repurgata et illustrata. 4to. Rotterodam, 1775.

W. Lewis, an Experimental History of the Materia Medica, 4to. 1761.—4th edit. by R. Akin, 2 vols. 8vo. 1791.


F. P. Dulk, Die Preussische Pharmakopöe, übersetzt und erläutert; 2te Aufl. 2 Th. Leipsig, 1830.


F. V. Mariat et A. J. De Leus, Dictionnaire universel de Matière Médicale et de Thérapeutique Générale, t. 6. 1829-34.


2. Rational Arrangements.—These have an actual relation with the bodies for which they are used, and are the classifications properly so called. They are founded on the properties of the substances treated; consequently, are as numerous as there are classes of properties. Thus, medicines may be arranged according to their
   a. Sensible properties (colour, taste, and smell.)
   b. Natural-historical properties (external form and structure.)
   c. Chemical properties.
   d. Physiological effects.

a. Classifications founded on the sensible qualities (colour, taste, and odour.)—Classifications of this kind are necessarily very imperfect, owing to the impossibility of defining sensations. Moreover, their use is very limited, in consequence of the colour, taste, and odour of bodies having no necessary relation to their medicinal properties. In the best executed arrangements of this kind, the denominations of many of the classes of orders are objectionable;—dissimilar bodies are brought together;—and similar ones separated.

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<th>III. Odorous and insipid</th>
<th>1. Fragrant</th>
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<td>1. Sweets</td>
<td>1. Camphreous aromatics</td>
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<td>2. Bitters</td>
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<td>3. Acidous</td>
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<th>IV. Odorous and sapid</th>
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<td>3. Acidous</td>
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<td>4. Camphreous</td>
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<tr>
<td>5. Spirituous</td>
<td>1. Vinous</td>
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The following writers have offered the best examples of this mode of classification:


A. P. A. Greaves, An Essay on the Varieties and Distinction of Tastes and Smells, and on the Arrangement of the Materia Medica. [Published by Dr. Duncan in his supplement to the Edinburgh New Dispensatory, 1829.]

b. Classifications founded on natural-historical properties.—By natural-historical properties, I mean those made use of in natural history. They are principally external form and structure. In living beings we find that peculiar structure denominated organized. The structure called crystalline is peculiar to mineral and other inorganic bodies.

A. Classifications of organized beings.—In the following works the vegetable substances employed in medicine are arranged according to their natural-historical properties:


The animal substances used in medicine are arranged in natural-historical order in the following works:


Both the vegetable and animal materia medica are arranged according to the natural system in the following works:


As in the subsequent part of this work the vegetable and animal substances used in medicines will be arranged in natural-historical order, it will be unnecessary here to offer any examples illustrative of it. I have referred this mode of arrangement principally on account of the great difficulties attending any other method, especially that founded on the effects of medicines.

Artificial method of Linneus.—This appears to me the best place for noticing those pharmacological works in which the Linnean artificial method of arranging plants is followed.

Car. A. Linné, Materia Medica, ed. 4a. curante J. C. D. Schrebero. Lipsiae et Ernegg, 1782.

P. J. Bergius, Materia Medica e Regno vegetabili, 2tom. ed. 2da. Stockholmiae, 1782.

Methods founded on the parts of organized beings employed.—In some works the vegetable and animal substances employed in medicine are classified according to the parts used; as barks, roots, seeds, secretions, &c.


B. Classification of inorganic substances.—I am unacquainted with any natural-historical arrangement of the inorganic substances of the materia medica; that is, of an arrangement founded on the external forms and structure of these bodies. Most writers who have followed the natural system in their descriptions of vegetable and animal medicines, have adopted a chemical classification for the inorganic medicinal substances; a mode of proceeding which I shall follow in this work. As an example of a natural-historical classification of minerals, may refer to the following work:—


It may perhaps be useful to present the student with a classification of all the crystallized substances employed as medicines; as far, at least, as their primary forms have been determined. And here I must explain that the forms of crystals are primary or secondary. “A primary form is that parent or derivative form from which all the secondary forms of the mineral species to which it belongs may be conceived to be derived according to certain laws.” (Brooke’s Familiar Introduction to Crystallography, 1823.) The secondary forms consist of all those varieties belonging to each species of mineral which differ from the primary form.

All the known primary forms may be arranged in six groups, or systems, as follows:—

**Group 1st. Regular or Cubic System:** (Octahedral System: Tessular System, Mohs).—The primary forms belonging to this group, are the Cube (or Hexahedron), the Tetrahedron, the Regular Octahedron, the Rhombic Dodocahedron, and the Trapezoctahedron. Of these the Cube is usually regarded as the fundamental form or type. The following pharmacological agents belong to this group:—

- Bismuth
- Carbon
- Copper
- Gold
- Iron
- Mercury
- Phosphorus
- Silver
- Chlорuret Sodium
- Bromuret Potassium
- Ioduret Potassium
- Muriate Ammonia
- Arsenious Acid
- Alum
- Galena (sulphuret lead).

**Group 2nd. Right Square Prismatic System:** (Square Prismatic System: Pyramidal System, Mohs).—The primary forms included in this group are, the Right Prism with a square base) also called Right Square Prism, or simply Square Prism), and the Octahedron with a square base. The first is considered to be the fundamental form. The following medicinal substances belong to this group:—

- Chloruret Mercury (Calomel)
- Bicyanuret Mercury
- Ferrocyanuret Potassium
- Red. Antimony (oxisulphuret).—(W. Phillips.)
- Copper Pyrites
- Peroxide Tin.

**Group 3rd. Right Rectangular or Right Rhombic Prismatic System:** (Right Prismatic System).—This group includes the following primary forms; the Right Rectangular Prism, the Octahedron with a rectangular base (Right Rectangular Octahedron), the Right Rhombic Prism, and the Octahedron with a rhombic base (Right Rhombic Octa
dron). The fundamental form is either the right rectangular or the right rhombic form. The following are the pharmacological agents belonging to this group:

- Bichloruret Mercury
- Sesquisulphide Antimony
- Carbonate Arsenicum (Orpiment)
- Carbonate Lead
- Carbonate Baryta
- Sulphate Potash

**Group 4th. Obligate Rectangular or Oblique Rhombic Prismatic System.**—The primary forms included in this system are, the Obligate rectangular Prism, the Obligate Octahedron with a rectangular base (Obligate Rectangular Octahedron), the Obligate Rhombic Prism, and the Obligate Octahedron with a rhombic base (Obligate Rhombic Octahedron). Mr. Brooke (Encyclopedia Metropolitana, art. Crystallography) refers the Right Obligue-angled Prism to this group. The fundamental form for this system is the Obligate Prism (either rectangular or rhombic). The following pharmacological agents belong to this group:

- Sulphur (by slow cooling) Sulphate Magnesia
- SulphideArsenicum (Realgar) Sulphate Zinc
- Carbonate Soda Nitrate Silver
- Sulphate Soda Nitrate Potash

**Group 5th. Doubly Obligate Prismatic System.**—This system includes the Doubly Obligate Prism (also called the Obligate Prism with an oblique-angled parallelogram for its base). The following pharmacological agents belong to this system:

- Sulphate Copper Acetate Copper
- Sulphate Cinchonia Acetate Zinc
- Nitrate Bismuth Tartaric Acid

**Group 6th. Rhombohedric System (Mohs).**—The primary forms of this group are, the Rhombohedron (also termed Rhomboïd), the Bipyramidal Dodecahedron, and the Regular Hexagonal Prism. The fundamental form is the Rhombohedron. The following pharmacological agents belong to this group:

- Antimony Carbonate Zinc
- Plumbago Bismuth Potash Mercury
- Carbonate Lime Hydrate Magnesia

**c. Classifications founded on the Chemical Constituents.**—The difficulties attending the analysis of organized substances form a great obstacle to the formation of a chemical classification. Most of the writers who have attempted an arrangement of this kind are German.

**Donald Munro, A Treatise on Medical and Pharmaceutical Chymistry, and the Materia Medica. London, 1788.**


**F. G. Voigtels, vollständ. System der Arzneimittel, herausg. von Kühn. 4 Bde. Leipzig, 1816-17.**

**C. W. Hyefland, Conspectus Materie Medicae, Berolini, 1816, ed. 2, 1820; ed. 3, 1828.**

**G. W. Schwartz, Pharmacologische Tabellen, oder system. Arzneimittel in resp. Form. Leipzig, 1819-25, 2 Aufl. fol. 1833.**

**G. A. Richter, ausführliche Arzneimittel, Handbuch für prakt. Aerzte. 5 Bde. 1. Suppl. 1826-32.**

As an example of a chemical classification I shall select Schwartz's, and must refer the reader to the late Dr. Duncan's (jun.) *Edinburgh Dispensatory*, 11th ed. p. 172, for Pfaff's chemical classification of the vegetable materia medica.
It will be observed that the author has not always founded his divisions on the chemical properties of medicines; some of them refer partly or wholly to the effects produced by these agents on the body. The nomenclature is not always perfect; thus, his seventeenth class is called "Metallica," as if it alone contained metallic substances; whereas divisions fifteen and sixteen also contain them. Again, some of the divisions, for example "Resinosa," contain substances whose effects are most dissimilar; while substances of analogous operation are placed in separate divisions.

\[\text{Schwartz's Classification.}\]


\[\text{d. Classifications founded on the Physiological Effects of Medicines.}—\text{As the ultimate object of all our inquiries into the materia medica is to obtain a knowledge of the mode of operation of medicinal substances, it follows, that the most desirable and useful, because the most practical, classification of these agents, would be that founded on the similarity of their effects. But so many difficulties exist in the way of producing such an arrangement—so much remains yet to be determined with respect to the nature of the modifications impressed on the organised tissues by the influence of medicines—that it must be evident to every one who attentively studies the subject, that in the present state of our knowledge no such classification can be satisfactorily effected.}\

\[\text{Of the numerous arrangements of this kind which have been attempted, some were founded on the nature, quality, or general character of the effects; as in the following works:—}\]

\[\text{W. Cullen, M.D. Treatise of the Materia Medica. Edinburgh, 1789.}\]
\[\text{R Pearson, M.D. A Practical Synopsis of the Materia Alimentaria and Materia Medica. London, 1808.}\]
\[\text{C. I. A. Schweilqué, Traité de Matière Médicale, 2 tom. Paris, 1818.}\]
\[\text{J. Arnemann, Chirurgische Arzneimittellehre, 6 Aufl. vind. A. Kraus. 1818.}\]
\[\text{J. Arnemann, praktische Arzneimittellehre, 6 Aufl. von L. A. Kraus 1819.}\]
\[\text{T. Young, M.D. An Introduction to Medical Literature, art. Pharmacology, 2nd edit. 1823.}\]
\[\text{J. B. G. Barbier, Traité Élémentaire de Matière Médicale, 2\textsuperscript{nde} éd. 3 tom. Paris, 1824.}\]
\[\text{N. Chapman, M.D. Elements of Therapeutics and Materia Medica, 4th ed. Philadelphia, 1835.}\]
\[\text{Dr. Nuttall, Lancet, 1825-6, vol. ix. p. 578.}\]
\[\text{C. Sauvain, Handbuch der speziellen Heilmittel, 2 Bde. 3\textsuperscript{e} Aufl. 1833.}\]
\[\text{John Murray, M.D. A System of Materia Medica and Pharmacy, 5th edit. Edinburgh, 1828.}\]
\[\text{A. Duncan, M.D. Physiological Classification of the Materia Medica. In the Supplement to the Edinburgh New Dispensatory, 11th ed. 1829.}\]
\[\text{J. Wendt, praktische Materia Medica. Breslau, 1830, 2 Aufl. 1833.}\]
\[\text{F. Foy, Cours de Pharmacologie, 2 tom. Paris, 1831.}\]
\[\text{A. T. Thomson, M.D. Elements of Materia and Therapeutics, 2 vols. 1832; 2nd ed. 1 vol. 1835.}\]
\[\text{E. S. and K. D. Schröff, Arzneimittellehre und Receptkunde. Wien. 1833.}\]
\[\text{A. Trouseau et H. Pidoux, Traité de Thérapeutique. Paris, 1\textsuperscript{er} tom. 1836. 2\textsuperscript{nd} tom. re part. 1837.}\]
\[\text{C. G. Mitscherlich, Lehrbuch der Arzneimittellehre. 1\textsuperscript{re} Bd. 1\textsuperscript{er} Abl. Berlin, 1837.}\]
The best arrangements of the authors just quoted are, in my opinion, those of Drs. Murray, Duncan, and A. T. Thomson. I subjoin that of Dr. Duncan:

DR. DUNCAN’S PHYSIOLOGICAL CLASSIFICATION OF THE MATERIA MEDICA.

External Agents act,

1. By nourishing the body
   (a) Drink
   When they act medicinally
   ALIMENTA.
   -
   -
   -
   -
   -
   -
   DILUENTIA.

   (b) Food
   When they act medicinally
   -
   -
   -
   -
   -
   -
   DEMULCENTIA.

1. By evacuation
   (a) By the skin insensibly
   EVACUANTIA.
   -
   -
   -
   -
   -
   -
   DIAPHORETICA.

   (b) By the mucous membrane
   Of the nostrils
   Of the lungs
   Of the stomach
   Of the intestines
   Of the uterus
   -
   -
   -
   -
   -
   -
   ERRHINA.

   (a) By glandular secretion
   The kidneys
   The salivary glands
   -
   -
   -
   -
   STIMULANTIA.

   (b) Of the system generally
   TOPICA.
   -
   -
   -
   -
   -
   -
   RUBEFACIENTIA.

1. By exciting the vital powers
   (a) Chiefly of the parts to which they
   Applied externally
   Causing redness
   -
   -
   -
   -
   -
   -
   VESICANTIA.

   Administered internally
   Condimenta when alimentary
   When acting medicinally
   -
   -
   -
   -
   -
   -
   SUPPURANTIA.

   (b) Of the system generally
   GENERALIA.
   -
   -
   -
   -
   -
   -
   CARMINATIVA.

1. By depressing the vital powers
   (a) Obscurely, but more durably
   Producing no immediate obvious effect
   PERMANENTIA.
   -
   -
   -
   -
   -
   -
   TONICA.

   (b) More evidently, but less durably
   TRANSITORIA.
   -
   -
   -
   -
   -
   -
   ASTRINGENTIA.

   Acting on the organic functions
   Acting on the mental functions
   -
   -
   -
   -
   -
   -
   INEBRIANTIA.

1. By chemical influence on the fluids
   Acifying
   Alkalizing
   CHEMICA.
   -
   -
   -
   -
   -
   -
   ACIDA.

A very cursory examination of the substances placed by the author under each of the above classes will satisfy the most superficial observer at this classification does not, in a large number of instances, effect at which it proposes to do; namely, to arrange together “substances according to the effects which they produce in a state of health.” For example, under the head of diaphoretics and sudorifics we have mustard, spaiva, opium, ipecacuanha, alcohol, antimony, ammonia, and mercury; among narcotics are opium, nux vomica, foxglove, saffron, and colchicum; in the class sialogogues we have, horseradish, tobacco, and mercury. Now no one will pretend to affirm that the substances thus grouped together operate in an analogous manner on the system, or that their effects are similar.
Some physicians have classified the articles of the materia medica in accordance with Brunonian principles. I have already mentioned that Brown regarded all medicines as stimulants; that is, as agents causing excitement. But he supposed some of them to produce less excitement than health requires, and, therefore, to be the remedies for asthenic diathesis: hence they were termed Debilitating or Antisthenic. On the other hand, some agents give more excitement than suits the healthy state, and are, therefore, the remedies for the asthenic diathesis. These he called Stimulant or Sthenic. (The Works of Dr. John Brown, vol. ii. p. 205, 1804.) The following pharmacological works are based on Brunonian principles: (Encyclopädisches Wörterbuch der medicinischen Wissenschaften, 3 Bd. art. Arzneimittellehre.)

Versuch einer einfachen praktischen Arzneimittellehre. Wien, 1797.

The partizans of the theory of contrastimulus divide medicines into two great classes: one comprehending those agents which augment or depress the excitability—(stimulants and contra-stimulants)—and which on that account are termed dynamics; the other contains all mechanical and chemical agents, under the denomination of irritants. (Dict. de Médecine et de Chirurg. pratiq. art. Contre-stimulant, par Andral.) I have already given a list of stimulants and contra-stimulants, and have pointed out some objections to the arrangement.

The followers of Broussais, the founder of what the French denominate the New Medical Doctrine, or Physiological Medicine, consider all medicines to be either stimulants or debilitants. When a stimulant is applied to the organ affected, it is termed a direct stimulant, but when applied to a part more or less distant from that affected, it is termed a revulsive, or sometimes an indirect debilitant. Hence medicines are divided into debilitants, direct stimulants, and revulsives. This is the plan adopted in the following work:


Another mode of classifying medicines is on chemico-physiologica principles; or, to use the phrase of Dr. Osann (Encyclop. Wörterb. med. Wissenschaften) “on the chemico-therapeutical basis of natural philosophy.” This method has been adopted in the following works:

Another mode of classifying medicines is to arrange them according to the particular structure or organ which they affect; as into medicines acting specifically on the nervous system; medicines acting specifically on the vascular system; and so on. Some authors have formed their principal divisions, or classes of medicines, from the parts acted on, and their orders from the nature or quality of the effect. The following writers have founded their classifications on the particular organs affected by medicines:

* J. L. Alibert, Nouveaux Éléments de Thérapeutique et de Matière Médicale. 5me. l. 3 t. Paris, 1826.
* Dr. Granville, Medical and Physical Journal for April, 1822, vol. xlvii.
* Ph. F. W. Vogt, Lehrbuch der Pharmakodynamik. 2 Bde. 2te Aufl. 1828.
* Dr. Michaelis, Encyclopädisches Wörterbuch der Medicinalen Wissenschaften. 1t. Arzneimittel. Berlin, 1829.

**Eberle's Classification.**

1. Medicines that excite discharges from the alimentary canal
   - Emetics.
   - Cathartics.
2. Medicines calculated to destroy or counteract the influence of morbid substances lodged in the alimentary canal
   - Antelmintics.
   - Antacids.
3. Medicines calculated to correct certain morbid conditions of the system, by acting on the tonicity of the muscular fibre
   - Tonics.
4. Medicines calculated to correct certain morbid states of the system, by acting on the contractility of the muscular fibre
   - Astringents.
5. Medicines calculated to promote the menstrual discharge
   - Emmenagogues.
6. Medicines calculated to increase the parietal efforts of the womb
   - Abortiva.
7. Medicines that lessen the sensibility and irritability of the nervous system
   - Narcotics.
8. Medicines that increase and equalize the nervous energy
   - Antispasmodics.
9. Medicines that increase the action of the heart and arteries
   - Stimulants.
10. Medicines that act on the cutaneous exhalents
    - General
    - Topical
11. Medicines that increase the action of the urinary organs
    - Diaphoretics.
    - Epistaxis.
    - Emollients.
12. Medicines that alter the state of the urinary secretion
    - Diuretics.
13. Medicines that promote the secretory action of the salivary glands
    - Antilithics.
14. Medicines calculated to increase the mucous secretion in the bronchia, and to promote its discharge
    - Sialagogues.
15. Medicines whose action is truly topical
    - Expectorants.
    - Inhalations.
    - Emollients.
    - Escharotics.

* I have given a sketch of this classification in the Medical Gazette, vol. xvii. p. 164.
11. Physiological Classes of Medicines.

In order to prevent repetition in the subsequent parts of this work, I have thought it necessary to make a few general observations on some of the more important and generally admitted physiological classes of medicines.

Class 1. Cerebro-Spinants.—I have considered it best to include in one class all those agents whose primary and specific effect is a disorder of one or more of the functions of the cerebro-spinal system (the cerebral and true spinal systems of Dr. M. Hall). To this class, therefore, are referred all those substances which occasion sleep, insensibility, erroneous perceptions, judgments, and volitions, or delirium, sopor, coma, paralysis, convulsion, &c.

Some of them produce very slight local effects, as opium; others occasion numbness and tingling, as aconite; conia causes local paralysis of a kind, the substances termed by toxicologists acro-narcotics or narcotic-acrid (as squills, tobacco, foxglove, &c.) when swallowed, occasion inflammation of the gastro-intestinal tube; alcohol, the preparations of arsenic, copper, of zinc, of bismuth, and of silver, act as powerful local irritants or caustics.

The cerebro-spinants may be thrown into groups or orders founded on their effects:

a. The first group includes those cerebro-spinants which occasion tetanic convulsions, and which have, in consequence, been termed tetanics. Here belong strychnia and brucia, and all substances containing one or both of these alkaloids, as the seeds of Strychnos Nux vomica; the bark of this plant (commonly termed false Angustura bark); St. Ignatius' bean; snake-wood (lignum colubrinum); and the Upas Tiuté poison; all of which probably ought to be added to the celebrated Tanghin poison. These substances of this order are principally employed in certain torpid or paralytic conditions of the muscular system, under regulations which will hereafter be pointed out.

b. The second group is made up of those cerebro-spinants which produce paralysis of the muscles, and is principally composed of conia, an alkaloid obtained from hemlock, whose physiological effects would point it out as the remedy for tetanus, and as the counter-poison for strychnia and brucia, and for the substances containing these alkaloids.

c. The third group includes those agents which occasion paralysis of the sentient nerves. Aconite or monkshood belongs to this group. It is the remedy, therefore, for neuralgia.

d. The fourth group is made up of those agents which, in large doses, occasion sudden loss of sensation and consciousness, with violent convulsions; in other words, an epileptic paroxysm. It includes hydrocyanic acid, the cyanurets of zinc and potassium, the bitter almond and its volatile oil, and the cherry-laurel and its distilled water. In a concentrate form, and in large doses, hydrocyanic acid sometimes occasions death without convulsions. This order contains the poisons which are the most rapidly fatal of any known. The similarity between the effects of large doses of hydrocyanic acid and an epileptic paroxysm are deserving of especial attention: moreover, we ought not to lose sight of the fact that a condition precisely analogous to, if not identical with, this state, is frequently produced by a large blood-letting. As therapeutic agents, th...
stances of this group are valuable in certain painful affections of the alimentary canal (of the stomach especially) unaccompanied by inflammation.

4. The fourth group includes those cerebro-spinants which occasion sleep or stupefaction, and, when given in large quantities, apoplexy. They are the narcotics properly so called. The most important is opium, which perhaps may be added henbane and lactucarium. In small doses they frequently cause excitement; in larger ones they diminish the contractility of the muscular fibre, or even occasion actual paralysis, lessen the sensibility of the body generally, and give rise to sleep or apoplexy. The apoplectic condition caused by the use of poisonous doses of opium has been denominated narcosis. In this state the pupils are usually contracted. The uses of this group may be inferred from its effects. In small doses opium is employed as a stimulant: in larger doses opium, henbane, and lactucarium, are employed to relieve pain, in which case they are denominated anodynes (from ανοΰνις, to soothe or alleviate); they are also used to diminish inordinate muscular contraction (convulsion or spasm) when they are termed antispasmodics; and, lastly, to procure sleep, when they are called hypnotics (υπνοτικος, from υπνος, sleep) or soporifics (from πορ, a deep sleep, and facio, I make.)

5. The fifth group is closely allied to the fourth, from which perhaps it ought not to be separated. It includes those agents which cause delirium, followed by sleep and stupefaction, and, when large doses are swallowed, apoplexy. This group, therefore, has been denominated inebriants or intoxicants. It contains alcohol, wine, and beer. These agents are remarkable for their great exciting properties, as well as for the peculiar delirium which they occasion, by both of which effects they are principally distinguished from the preceding group. By long-continued use, alcohol occasions the disease termed alcoholic tremens, and which is characterized by wakefulness, delirium, and tremor. Inebriants are used in medicine on account of their stimulant qualities.

Musk, valerian, and some other substances usually denominated poisons, though closely related to this group, may with more propriety be noticed under the head of stimulants.

6. The sixth group is a provisional one to contain belladonna and stramonium, the mode of operation of both of which substances is less perfectly understood than of some of the before-mentioned medicaments. The first of these causes dilatation of the pupil, obscurity of vision, dryness of the throat, difficult or impossible deglutition, aphonia, difficulty of articulation, faintings, and delirium, followed by sopor or highness of spirit: convulsions are rare. Laennec (Dr. Forbes's Translation, p. 77, 27) says that it relieves dyspnœa by diminishing the necessity for inspiration. In a case related by my friend Dr. T. Davies (Lectures Diseases of the Lungs and Heart, p. 496) a plaster of belladonna applied to the abraded skin cured a severe form of angina pectoris. Ulsters employ belladonna to dilate the pupil.

7. The seventh group includes tobacco and foxglove, both of which are remarkable for their depressing influence on the circulating organs, in consequence of which they are denominated sedatives. When taken internally, in large doses, they give rise to nausea, vomiting, giddiness,
feebleness and irregularity of pulse, faintings, convulsions, and insensibility. Tobacco is remarkable for producing excessive feebleness of the muscular system. Foxglove sometimes causes salivation. Both substances have been employed to reduce the frequency and force of the heart's action, and to cause diuresis; tobacco has been used as a purgative in hernia and intus-susception.

h. The eighth group contains certain metallic preparations which act specifically on the nervous system, such as the preparations of bismuth, copper, silver, and zinc. Their local action is irritant or caustic. Their influence over the cerebro-spinal system is shown by their remedial power in some disorders of this system, as epilepsy and chorea (in consequence of which they have been termed antispasmodics) and by the giddiness, cramps or convulsions, paralysis, coma, &c. when taken in poisonous quantities. In small doses they are considered to act as tonics, principally on account of their beneficial agency in periodical diseases, especially ague. This group corresponds very nearly to that called by Vogt, nervino-alterantia.

i. The ninth group contains the plumbeous preparations, which are remarkable for producing colic and paralysis. These compounds are usually called astringents.

k. The tenth group is formed to include mercurial compounds, which by long-continued action in small quantities, cause a convulsive movement of the muscles (tremor mercurialis) as in chorea.

Notwithstanding the numerous groups or subdivisions of the class cerebro-spinants, which I have thought it necessary to make, more probably ought to be added. If, as Dr. Hall believes, the tone of the muscular system is derived from the true spinal system, the substances called tonics should form a group of cerebro-spinants rather than a distinct class. Moreover, the medicines known as antispasmodics (such as asafoetida) ought perhaps to be placed in this class, on account of their remarkable influence in hysteria and infantile convulsions.

Cause or mode of death.—The immediate cause or mode of death from the use of cerebro-spinants is not always the same,—in some instances it is an affection of the respiratory organs, in others of the heart.

a. Paralysis of the muscles of respiration.—In some cases the respiratory muscles do not receive their proper supply of nervous energy, in consequence of which respiration is performed with increasing difficulty, until, ultimately, asphyxia is produced. This kind of death is caused by opium, and sometimes by dilute hydrocyanic acid. Before the cessation of life we observe the breathing to become laborious or even stertorous, as in cases of apoplexy; and if the body be opened immediately after death, the heart is found beating, oftentimes with considerable force and for some minutes. These are the cases in which it has been proposed to prolong life by artificial respiration until the cerebral disorder has passed off. The proposition is not supported merely by its ingeniousness and plausibility, but by experience. The following is a case in point related by Mr. Whateley, and quoted by Dr. Christison (Treatise on Poisons, p. 680, 3d ed.) A middle-aged man swallowed half an ounce of crude opium, and soon became lethargic. He was roused from this state by appropriate remedies, and his surgeon left him. But the poison not having been sufficiently discharged, he fell again into a state of stupor; and when the surgeon returned, he found
he face pale, cold, and deadly, the lips black, the eyelids motionless, so as to remain in any position in which they were placed, the pulse very mall and irregular, and the respiration quite extinct. The chest was immediately inflated by artificial means, and when this had been persevered in for seven minutes, expiration became accompanied with a croak, which was gradually increased in strength till natural breathing was established; emetics were then given, and the patient eventually recovered. Another most interesting case of recovery, from poisoning by opium, by artificial respiration, has been detailed by Mr. Howship (Medico-Chirurgical Transactions, vol. xx. p. 86). I have several times restored animals apparently dead from the use of hydrocyanic acid, merely by keeping up artificial respiration, and Sir Benjamin Brodie has done the same with animals apparently killed by the oil of bitter almonds.

b. Closure of the larynx.—When an attempt is made to inspire pure carbonic acid, as well as some other gases, the larynx spasmodically loses, and death results from asphyxia. In a case of complete insensibility from intoxication related by Mr. Sampson (Medico-Chir. Trans. vol. xx. p. 46), the comatose state was thought to arise, not from popplexy, "but from torpor of the brain, in consequence of that organ being imperfectly supplied with blood not duly oxygenated; for the thrill tone and extreme difficulty of respiration shewed the existence of collapse of the glottis, and imperfect transmission of air into the lungs, which might be accounted for by a paralysed state of the eighth pair of nerves and recurrent branches." Tracheotomy was performed, and with complete success: in about half an hour the respiration was regular and easy through the wound.

c. Convulsion or spasm of the respiratory muscles.—Another cause of death brought on by cerebro-spinans is spasm of the respiratory muscles, whereby the function of respiration is stopped, and asphyxia produced. We have an example of this mode of operation in death by strychnia, lucia, and the substances containing these alkaloids.

d. Paralysis of the heart.—In some instances the immediate cause of death appears to be paralysis of the heart. Thus in some cases of poisoning, the heart ceases to beat before respiration has stopped,—as when the alcoholic extract of aconite is applied to wounds in dogs. If the chest be opened, the heart does not contract as usual when irritated by a needle. Sir Benjamin Brodie says the infusion of tobacco kills dogs and cats by paralysing the heart.

In the case of poisons acting in this way, it has been proposed to imitate the heart by slight galvanic shocks in order to avert the fatal termination. Even acupuncture has been advised, if the patient appeared in articulo mortis. Bretonneau (Bayle, Travaux Thérapeutiques, i. p. 432) has repeatedly punctured the brain, heart, lungs, and stomach of young dogs, without the least inconvenience; and Carraro (Expériences sur des animaux asphyxiés et ramenés à la vie par l'acupuncture du cœur, in Bayle, op. cit. t. i. p. 495) has successfully tried this practice on animals in a state of asphyxia.

Sent and nature of the action of cerebro-spinans.—Those cerebro-spinans which, by their primary action, occasion lesions of the mental emotions, of sensibility, and of volition or voluntary motion (such as pain insensibility, erroneous perceptions, judgments, and volitions or deli-
rium, or a total deficiency of these faculties, or coma, or continual voluntary actions or paralysis) are presumed to act specifically on the cerebral, or sentient and voluntary system. Opium, alcohol, and aconite, may be mentioned as examples of agents acting on this part of the nervous system.

On the other hand, those cerebro-spinants which occasion convulsions or spasms affect the true spinal or excitomotory system of Dr. Hall. Thus strychnia, hydrocyanic acid, belladonna, and most of the metallic cerebro-spinants, act on this portion of the nervous system.

The precise pathological condition of the brain or spinal marrow produced by cerebro-spinants has not been satisfactorily ascertained. Some of them (as opium) give rise to a congested state of the cerebral vessels, but this may be a secondary effect.

*Active principles.*—The active principles of each of the cerebro-spinants will be examined separately in a subsequent part of this work; but as several of the vegetables of this group owe their activity to alkaloids, it will be useful to point out here the general properties of these bodies.

The *vegetable or organic alkalies,* or the *alkaloids,* have only been recognised during the present century. They are salifiable and inflammable compounds of carbon, hydrogen, nitrogen, and oxygen. Most of them are solid, inodorous, and crystallizable, but conia is odorous and liquid at ordinary temperatures. They are usually fixed; but some of them, as cinchonia and daturia, are volatile at elevated temperatures. They react on vegetable colours as alkalies, and unite with acids, to form salts; but their saturating power is very low, that is, their atomic weights are very high. Each atom contains one equivalent of nitrogen. Those alkaloids which are best known are only slightly soluble in water; but, in general, they readily dissolve in hot alcohol, and frequently separate in a crystalline state from this liquid, as it cools. Their taste is bitter or acrid.

Tannic acid unites with them to form tannates, which usually are very slightly soluble only in water. Hence the infusion of galls (which contains this acid) is employed for detecting the alkaloids, and as an antidote in poisoning by them. Iodic acid, in excess, precipitates several of them; but is decomposed by morphia, iodine being set free. Concentrated nitric acid reddens morphia, strychnia, and brucia, and gives a yellow tinge to narcotine; but a green one to aricina. Bichloruret of mercury precipitates the hydrochlorates of some of these alkaloids, forming with them double salts. The sulphates, nitrates, hydrochlorates, and acetates of the alkaloids, are generally soluble in water. Ammonia and magnesia decompose these solutions, and precipitate the alkaloid.

The usual method of obtaining the vegetable alkalies is to digest and boil the substances yielding them in water, acidulated with hydrochloric acid. To the filtered liquor add ammonia, lime, or magnesia, and subsequently purify (by repeated solutions in alcohol) the precipitated alkaloid.

Raspail (*Nouveau Système de Chimie Organique*, p. 488) maintains that the alkaloids are artificial combinations of a vegetable acid (benzoic?) and excess of ammonia, with perhaps a resinoid substance. But there are no just grounds for such a conclusion. It is, however,
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Preserving of notice that each atom of the alkaloid contains precisely the quantity of nitrogen which exists in one atom of ammonia. The vegetable alkaloids act powerfully on the animal economy; but they present too much diversity in their mode of operation to allow of any general remarks being made thereon. Some are most energetic poisons; for example, strychnia and aconitina; others, which cannot be called poisonous, are powerful and valuable remedies, as quinia.

Class 2. Stimulants, Incitants, or Excitants.—An agent which increases the vital activity of an organ is termed a stimulant (from stimulus, good or spur), or sometimes an incitant (from incito, to incite or spur), or excitant. Those which affect all the organs or functions of the system are termed general stimulants; while others, which influence one or two organs only, are called special stimulants. Those which excite the parts to which they are applied are frequently denominated local stimulants, or irritants; though the term local is used by Murray (System of Materia Medica) to indicate the substances which I have here termed special stimulants.

The vital or vivifying stimuli (a certain degree of external heat, atmospherical air, water, and nutriment) are to be distinguished from the agents used in medicine under the name of stimulants. The former are essential to vitality: they renovate the tissues, by entering, in a manner indispensable to life, into their composition; and, lastly, their continued action does not give rise to exhaustion. The latter, on the other hand, are not necessary to life: they have no renovating action; but, by raising reaction, give rise to exhaustion. Moreover, the so-called stimulants do not merely excite; most of them act as alteratives, and many of them, by long-continued use, or by employment in too large quantities, destroy life.

Stimulants, for the most part, produce their effects by the agency of the nervous system (i.e. the true spinal and ganglionic systems), and probably in a considerable number of instances by a reflex action. Many of them become absorbed, and have been recognised in the blood and secretions.

Stimulants are closely related to some other classes, especially to cerebro-spinants, tonics, and some of the evacuants. Thus, alcohol and ether are at the same time stimulant and narcotic; myrrh, eacarilla, and the ferruginous compounds, possess both stimulant and tonic qualities; lastly, several of the stimulants are sudorific, diuretic, emmenagogue, &c.

Most stimulants are odorous,—many of them indeed powerfully so. Their taste is warm, acrid, and pungent. Swallowed in moderate quantities, they give rise to a sensation of warmth in the stomach, expel aqueous matters, and assist digestion. In larger quantities, they excite thirst, and often give rise to nausea or vomiting. Many of them increase the force and frequency of the heart’s action, and promote the warmth of the surface of the body.

They may be arranged in groups, founded in part on their chemical composition, and in part also on their effects.

a. The first group is one which was termed by the late Dr. Duncan (Supplement to the Edinburgh Dispensatory, p. 229), volatile pungent stimuli. It includes the official substances belonging to the order Cruciferae (such as mustard and horse-radish) and certain bodies of Umbelliferae (garlic, the onion, and the leek). These substances contain a
volatile, acrid principle (oil) which renders them local irritants. Several of them are employed as condiments. In medicine, we use mustard as a rubefacient and emetic; horse-radish as a masticatory; and garlic as a stimulating expectorant. From their beneficial effects in scurvy, the substances of this group have been denominated antiscorbutics.

b. The second group contains the aromatic plants of the family Labiatae, several of which are used in cookery under the name of sweet or savoury herbs, and the carminative fruit of several umbelliferous plants. Volatile oil is the active principle of the whole group. In the labiate plants this resides in small receptacles in the leaves, while in the umbelliferous fruit it is contained in clavate vessels called vittae, situated in the pericarpial coat. Cooks employ some of the substances of this group to form seasoning for certain kinds of dishes or meats. The liqueur-maker uses some of them for flavouring his cordials. In medicine we employ them principally as flavouring or carminative substances. Thus they are added to many other medicaments, the unpleasant odour or taste of which they are intended to cover, and whose nauseating properties they check. They are also useful in flatulency, and in spasmodic affections of the alimentary canal, especially the flatulent colic of children.

c. The third group consists of the substances called spices (aromata). These are the products of warm climates, as the Molucca or Spice Islands, Ceylon, the West Indies, &c., and are obtained from the orders Scitaminece, Lauracece, Myrtacece, Piperacece, Myristacece, &c. They owe their strong and grateful odour and taste principally to an acrid volatile oil. When applied to the skin, some of them (as pepper) act as powerful acrids, and excite local inflammation. Taken internally, in moderate quantities, they stimulate the stomach, create a sensation of warmth in this viscus, and promote digestion and assimilation. In larger quantities they occasion thirst, increase the fulness of and accelerate the pulse, and produce a febrile condition of body. In doses of two drachms, nutmegs have acted as narcotics.

Spices are distinguished from the last group of stimulants by their more agreeable flavour, by their greater acidity, by their less tendency to occasion nausea, and by their more powerful agency in promoting the assimilation of substances reputed difficult of digestion. Both groups, however, yield condiments.

In domestic economy spices are employed, partly for their agreeable flavour, and partly to promote the digestion of those kinds of food which, experience has shown, are not by themselves easily or readily digested.

In medicine they are used as flavouring ingredients, as carminatives, as antispasmodics, and as cordials or stimulants. Thus they are added to other medicines to correct their nauseous flavour, or their griping qualities. They are given to relieve flatulency and cramp at the stomach; to assist digestion in enfeebled or relaxed habits; to allay griping pains of the bowels, and to check purging in some mild forms of diarrhoea. Some of them (pepper and ginger) are applied to the skin as rubefacients, or are chewed as masticatories. Pepper has been successfully employed in intermittentts, cubebs in gonorrhoea. The volatile oil of some of the spices (as of cloves or allspice) is occasionally placed in the hollow of a carious tooth to allay tooth-ache.
On account of their acrid and heating properties, spices are objectionable in inflammatory conditions of the alimentary canal, and in febrile conditions of system.

**d. The fourth group** includes four sub-groups formed respectively by the solid resins, the oleo-resins, the balsams, and the frankincense. These differ not only in their chemical composition, but also to a certain extent in their effects and uses, they will require separate examinations. But being so closely related to each other, they could not, with propriety, be formed into distinct groups.

1. **Resins (resinae).**—Under this head I include elemi, mastic, and guaiacum, obtained respectively from the orders Burseraceae, Anacardiaceae, and Rutaceae. They exude either spontaneously or from incisions made to the stems of the plants yielding them. Common resin obtained as a residue in the distillation of the turpentines, may, in regard to its chemical and medicinal qualities, be placed in the same sub-group with the natural resins. These bodies agree in the following properties:—They are fusible and inflammable, and consist of resin principally combined with a small quantity of volatile oil: they are insoluble in water, but dissolve either completely, or nearly so, in alcohol, ether, and volatile oils: they combine with alkalies, saturating them as weak acids. Their local action is irritant: applied to the skin they act as rubefacients, and when swallowed in large doses, produce heat of stomach, nausea, vomiting, or even purging. Their constitutional effects are those of stimulants. Thus they occasion thirst, quicken the pulse, raise the temperature of the surface, and promote the secretions, especially of the skin and kidneys. Elemi and mastic are rarely employed in medicine: their effects are analogous to the turpentines, but much milder. Guaiacum is used as a stimulant and sudorific.

2. **Oleo-resins (oleo-resina; liquid resins; balsams devoid of benzoic acid; reebinhanates).**—These are oleo-resinous, semi-liquid, or glutinous juices, which flow spontaneously, or by incisions, from various vegetables, especially belonging to the orders Conifera, Burseraceae, Anacardiaceae, and Amyridaceae. Their liquidity or semi-liquidity, their odour, and most of their medicinal activity, are owing to the volatile oil which they contain, and which may be procured from them by distillation. From the true balsams they are distinguished by the want of benzoic acid. They have a strong odour, which, in some, is very fragrant,—in others, peculiar as to be taken as the type of certain odours under the name terebinhinate. Those oleo-resins, employed in medicines, are the turpentines, copaiva, and opobalsamum (commonly termed Mecca balsam). Their taste is hot and acrid. They are all local irritants, causing rubefaction when applied to the skin; and some of them giving rise to active inflammation. When swallowed they occasion more or less irritation of the alimentary canal, according to the dose in which they are taken; the symptoms being epigastric heat, loss of appetite, nausea, or even vomiting; and, sometimes, when the quantity swallowed is large, gripping or urging.

The constitutional effects are thirst, dryness of the mucous membranes, increased frequency and fulness of pulse, and great heat of skin, frequently accompanied with sweating. The oleo-resins exercise a stimulant influence over the urinary organs, which is manifested by uneasiness in the region of the kidneys, increased desire of passing the urine, heat
in the urethra, and sometimes strangury and bloody urine. Under the
influence even of small doses of the oleo-resins the urine acquires a
remarkable odour; and when any of the turpentines have been taken,
it is that of violets. The mucous membranes generally are stimulated,
and have their secretions diminished by the oleo-resins. We ob-
serve this not only in the case of the urino-genital mucous membrane,
but also in the membran lining the air-passages. By the repeated use
of the oleo-resins an eruption sometimes appears on the skin. In large
doses oil of turpentine causes an affection of the nervous system, which
will be noticed hereafter.

The oleo-resins are principally employed in medicine to modify
diseases of the mucous membranes, especially that lining the urino-
genital apparatus. Thus they are employed, and with great ben-
fit, in gonorrhcea, leucorrhcea, gleet, and chronic catarrh of the bladder.
In chronic pulmonary catarrh they are sometimes advantageously em-
ployed. Oil of turpentine has been used in neuralgia, against tape
worm, in puerperal peritonitis, and in other cases which will be noticed
when speaking of that substance in a subsequent part of this work.

γ. Balsams (balsama naturalia: balsams containing benzoic acid).—The
term balsam was formerly applied to all liquid vegetable resins, as well
as to many pharmaceutical preparations. But to avoid confusion,
the French chemists confine the term balsam to vegetable substances
composed of resin and benzoic acid, with more or less volatile oil. The
objection to this is, that the substances usually and popularly known by
the name of copaiva and Mecca balsams are, therefore, excluded from
the list of balsams. Hence most of the German chemists retain the old
acceptation of the term, and divide balsams into those which do, and
those which do not, contain this acid.

Balsams (under which term I include those only which contain benzoic
acid) are solid, soft, or liquid substances, according to the quantity of
volatile oil which they contain: they have an aromatic, usually agreeable,
odour, and a warm, acrid taste. They dissolve in alcohol; and the
solution, when mixed with water, becomes milky, owing to the deposi-
tion of resin. By sublimation, as well as by other methods, they yield
benzoic acid.

Those employed in medicine are benzoin, styrax, tolu, Peruvian bal-
sam, and liquidambar. They are obtained from the orders Styraceae,
Amyridaceae, Balsameae. They owe the principal part of their medicinal
activity to the contained benzoic acid. The liquid balsams (of styrax
and Peru) are sometimes applied to chronic indolent ulcers, to allay pain,
to improve the quality of the secreted matter (detergents), and to promote
cicatrization (epulotics or cicatrisantia). Taken internally the balsams
act as stimulants, their operation being principally directed to the
mucous membrane of the air-passages; on this account they are termed
expectorants, and are employed in chronic catarrhs. MM. Trousseau
and Pidoux (Traité de Thérapeutique, t. i. p. 467) assert, from their own
experience, that "there are few substances in the materia medica so
powerful in combating chronic pulmonary catarrhs and old laryngeal
inflammations as the balsams." In chronic inflammation of the larynx,
whether accompanied or not by ulceration, balsamic fumigations are
more serviceable than the internal exhibition of the balsams. The air of
the patient's chamber may be impregnated with balsamic vapours by
acaying a little benzoin or tolu in some live coals, and allowing the
vapour to escape into the room: or the patient may inhale the vapour of
boiling water to which a drachm or two of the balsams have been added.

\[5. \text{Fectid or antispasmodic gum-resins (gummi-resinae fætidæ).} \]

The gum-resins, usually denominated fætid or antispasmodic, are asafoetida, amnoniacum, galbanum, saganenum, and opoanax, all of which are
obtained by incision from plants of the order \textit{Umbelliferae}, growing, for
the most part, in Persia. They are composed principally of gum and resin, but with a small quantity of volatile oil, to which they are mainly
debted for their odour. Rubbed with water, they form a milky fluid
demulsion. They are not completely soluble in pure alcohol, though
they form therewith a clear tincture, which becomes milky on the
addition of water, by the precipitation of the resin as a white powder.
they dissolve, however, in boiling dilute alcohol. They are likewise
double in vinegar. Their odour is strong and remarkable; their taste
barm and acrid. Applied to the skin they act as mild stimulants.
Taken internally they give rise to a sensation of warmth in the stomach,
and cause eructations. The odorous particles of asafoetida become
absorbed, and may be recognised in the blood and secretions. The
fætid gum-resins have been principally, and most successfully, employed
in hysteria, flatulent colic, spasmodic asthma, chronic bronchial affec-
tions, and in uterine disorders. From their beneficial influence in the
rest of these diseases, they are inferred to possess a power of specifically
affecting the nervous (the true spinal) system.

\[6. \text{Myrrh} \] is a gum-resin procured from a plant of the order \textit{Burseraceae}.
It does not possess the antispasmodic power of the fætid gums, but
approaches nearer to the tonics.

\[7. \text{Olibanum} \] is also a gum-resin obtained from the same order as
myrrh. Its stimulant properties are principally directed to the mucous
embranes; and, in this respect, it is analogous to the resins, or rather
to the oleo-resins.

\[8. \text{The fifth group} \] includes ammonia and its salts, the empyreumatic
balsams, phosphorus, musk, and castoreum. It is termed by Vogt (\textit{Lehrb.
Pharmakodyn.}) volatile nervines (\textit{nervinia volatilia}). All the substances
of which it is composed agree in producing a primary and specific effect
in the nervous system, the energy and activity of whose functions they
talt. According to Vogt (\textit{op. cit. Bd. i. p. 186}) the more volatile the
remedy, the more it increases the activity of the nervous functions, and
the more fixed, the more it raises their energy. Thus, according to the
same writer, the preparations of ammonia raise the activity more than the
energy of these functions; the empyreumatic oils somewhat less; musk
still less; while castoreum increases the energy of the functions principi-
ally. However, I shall hereafter show that the last-mentioned remedy
clearly possesses very little power.

These remedies act as excitants to the organs of circulation, increas-
ing the force and frequency of the pulse, augmenting the warmth of skin,
and promoting diaphoresis. On account of the latter effect they have
ten termed \textit{diaphoretica calida}. Though the particles of some of them
ass into the blood, yet the constitutional effects cannot be regarded, in
tall cases, as the result of absorption, since, in several, they occur too
peedily to admit of this conclusion. And, as these effects are not
always proportionate to the local irritation and pain produced, they
cannot be referred to the latter. We therefore ascribe them to their specific impressions on the nerves of the part to which they are applied.

The effects of the substances composing this group are very quickly produced, and soon disappear. Consequently these remedies are adapted to urgent and acute cases, when the danger is imminent, and an immediate effect desired: for the same reason they require to be frequently repeated in order to keep up their effects. From their exciting operation they are indicated in cases of debility and sinking of the vital powers. Thus they are employed in syncope, low fevers, cholera, &c. On account of their specific influence over the nervous system they are administered in various spasmodic or convulsive diseases, especially in hysteria, and also in epilepsy and chorea.

f. The sixth group contains camphor, the roots of serpentina, con- trajerva, and valerian, the oil of cajuputi, &c. It corresponds with the division of volatile excitants called by Vogt, aetherio-oleosa; it is a less perfect group than any of those already mentioned. To a certain extent it agrees in its effects with the last mentioned: thus it specifically stimulates the nervous system, increases the activity of the vascular system, and produces diaphoresis. Its effects, however, are much less powerful, are not so speedily produced, nor are they so fleeting. Some of the substances of this group (for example, serpentina and contrajerva) are serviceable in low nervous fevers; others are used in spasmodic diseases, as valerian in epilepsy.

g. The seventh and last group is the spirituosa of Vogt. It comprehends those substances already mentioned under the head of cerebro-spinants, as inebriating; namely, alcohol, wine, and ether. Their effects and uses will be fully described in a subsequent part of this work.

Active principles.—Volatile oil and resin are the most common constituents of the foregoing groups.

1. Volatile oil (oleum volatile, vel atherum, seu essentiale).—Volatile oil is found in both the inorganised and organised kingdoms of nature: it is most common in vegetables. Petroleum and naphtha are examples of volatile oil in the mineral kingdom. Among animal substances castoreum may be referred to as containing it. It is found in various parts of vegetables— as in the cortical parts of their stems, in cinnamon and cassia; in their rhizomes, as in ginger and Acorus Calamus; in the root, as in valerian and horse-radish; in the leaves, as in buchu, Labiate, and Myrtaeeae; in buds, as in the bulbs of garlic and onions; in fruits, as the orange and Umbelliferae; and sometimes, though very rarely, in the seeds, as in the nutmeg. From these different parts it is occasionally obtained by pressure, but more commonly by distillation.

The volatile oils may be solid or liquid at ordinary temperatures; when solid they are crystalline. They may be lighter or heavier than water; their sp. gr. varying from 0'627 to 1'094 (Gmelin). They may be coloured or colourless; if the former, the tint is various in different oils. All the essential oils have a strong odour, and a hot acid taste. They are easily volatilised by heat; are combustible, in consequence of the large quantity of carbon and hydrogen which they contain; and are decomposed by chlorine, iodine, bromine, and the acids. Some of them (as the oil of turpentine) combine with hydrochloric acid. They are very
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lightly soluble only in water. The distilled waters of the Pharmacopoeia are saturated solutions of them. If the oils be previously rubbed with sugar they dissolve more readily in water. The mixtures or compounds of volatile oils and sugar are called eleosacchara. According to the Russian Pharmacopoeia they consist of one drop of oil to a scruple of sugar. Volatile oils dissolve readily in alcohol, ether, pyroxilic spirit, and naphtha, and easily mix with the fixed oils and resins.

The volatile oils, as ordinarily met with, usually consist of two oils—one liquid, at ordinary temperatures (volatile oil, properly so called; the éléoptène of Berzelius; the hygrusin of Bizio)—the other solid (stéaroptène of Bezelius; steresin of Bizio; camphor of the German chemists). When the latter predominates, the oil readily concretizes in old weather—as the oil of anise and the oil of star-anise. The camphor of the shops is the solid volatile oil (stéaroptène) of Camphora officinarum.

In regard to ultimate composition the volatile oils vary. Some consist of carbon and hydrogen only—as those of turpentine, juniper, savin, santon, and bergamot. Others contain also oxygen—as lavender, anise, mint, and rosemary: while a third class contain no less than five ingredients; namely, carbon, hydrogen, oxygen, sulphur, and nitrogen; as the volatile oil of mustard. It is remarkable that all the volatile oils which contain carbon and hydrogen only, (10 C + 8 H) have the same ultimate composition; or, at least, they consist of the same elements in the same relative proportion.

The volatile oils undergo chemical changes when exposed to the air. They become deeper coloured and thicker, absorb oxygen, and give rise to the formation of carbonic acid and resin. The resins of turpentine and copaiva appear to be simple oxides of their respective oils.

2. Resin (resina).—This is rarely found in the mineral kingdom, or in animal substances; but is common in vegetables. In the latter it exists almost invariably, if not universally, in combination with volatile oil, from which, perhaps, it may be formed by the action of the oxygen of the air. It is a transparent or partially opaque, hard, soft, or elastic solid; coloured or colourless; lighter or heavier than water, its sp. gr. varying from 0.93 to 1.0 (Gmelin); fusible and combustible. It is a bad conductor of electricity, and becomes strongly negatively electrical by friction. As commonly met with it is odorous, but probably, if completely deprived of volatile oil, would be inodorous. Its taste is usually more or less acrid; sometimes bitter, and, occasionally, is not perceptible. It is not soluble in water, though some resins form hydrates with this liquid. It is soluble in ether and volatile oil, and frequently more or less in alcohol; and on the addition of water to the alcoholic solution the resin is thrown down as a white powder, which gives a milky appearance to the fluid.

Most resins possess acid properties; that is, they redden litmus, and combine with alkalies and other metallic oxides. This is the case with the two resins (pinic and sylvic acids) of which colophony is composed; as well as the resin of copaiva (copaivic acid); of guaiacum (guaiacic acid); of gamboge (gambogic acid), &c. The compounds formed by the union of resins with alkalies, or other basic substances, are called resinous soaps. The sapo-guajacinus and sapo-jalapinus of the Prussian Pharmacopoeia, as well as the savon de térébinthine (Starkey's soap) of the French Codex, are soaps of this kind, and will be noticed hereafter.
The resins are composed of carbon, hydrogen, and oxygen. In some cases they appear to be oxidized essential oils, (1 oil of turpentine + oxyg.) as will be shown when speaking of turpentine and copaiva resins. It is not improbable that the first degree of oxygenation of the volatile oils forms resins insoluble in cold alcohol, while the most oxygenated are soluble in this liquid.

Class 3, Tonics.—Under the denomination of tonics are usually comprehended those therapeutic agents which, by continued administration in debilitated and relaxed conditions of the body, increase gradually and permanently the tonicity or insensible contractility of the whole system, and thereby render the fibres tenser and stronger, and give greater firmness and density to all the tissues and organs. They have received their names from róve, tone or vigour, on account of their strengthening or invigorating properties; and by some they have been termed corroborants.

Tonics produce their proper or real tonic effects in certain conditions of the system only; that is, they do not invariably strengthen. In some cases they give rise to no obvious results—in others they act as irritants and stimulants. In the healthy state moderate doses produce no sensible effects, or, perhaps, a slight excitement of the appetite merely, while large quantities give rise to nausea and vomiting. In irritation or inflammation of the stomach and intestines, and in febrile conditions of system, attended with a hot and dry skin, and a furred and dry tongue, tonics act as local irritants and excita"
probably be referred to the specific effects of these agents on the nervous system. And, in the same way, we ought to explain the power of tonics to increase the tone of the muscular system; for it appears, from Dr. Marshall Hall's experiments, that one function of the true spinal or eito-motory system is to give tone to the muscles.

The preparations of arsenic, silver, copper, bismuth, zinc, &c., are usually, but, as I think, most improperly, denominated tonics. They are agents which, in small and repeated doses, as well as in large and poisonous doses, specifically affect the nervous system, and I have already noticed them as cerebro-spinants. They have been called tonics principally for the following reason:—cinchona, the most powerful of the vegetable tonics, and in fact the type of the class, has long been celebrated as a curative agent in ague and other periodical diseases; hence it has been assumed that any substances capable of fulfilling the same indication must be possessed of the same properties, and thus arsenic has been called a tonic. But the conclusion is erroneous; it is indeed true that cinchona and arsenic have, in common, the power of curing an ague, but the same effect is frequently produced by many other very dissimilar substances: for example, by bloodletting, by alcohol, and by mental influences. If, therefore, arsenic be a tonic, so also must bloodletting, &c. If we admit this, it follows tonics can no longer be regarded as substances promoting strength, but merely as agents curing particular diseases. Before we have any right to associate arsenic among tonics, we must completely alter our definition of these substances, or show that arsenic improves the appetite and promotes the strength of the body.

Tonics may be arranged in groups, as follow:

a. The first group includes those vegetable tonics which possess astringency with little or no astringency; and which have been termed the bitters (amara), or sometimes the pure or simple bitters (amara pura seu simplicia). To this group are referred quassia and simaruba, obtained from the order Simarubaceae; gentian, American calumba (Fraseria), harayita, common centaury, and buckbean, from Gentianaceae; calumba and Pareira brava from Menispermaceae; and Cetraria Islandica, from Lichenaceae. These remedies are employed to promote the appetite and assist digestion in atonic and enfeebled conditions of the stomach; as general tonics in feebleness and debility of the whole system, and especially of the muscles; as antiperiodics in intermittent diseases; and as astringents. Their beneficial operation in expelling intestinal worms has been referred to their poisonous influence over these parasitical animals, but ought perhaps rather to be ascribed to their improvement of the condition of the alimentary canal, and to their removal of those wastes which favour the production of these beings. The power which bitters possess of retarding the acetous fermentation may, perhaps, contribute to their beneficial operation in some dyspeptic cases accompanied with acidity and flatulence.

b. The second group comprehends those vegetable tonics which possess considerable astringency (from the contained tannic acid) with little or no bitterness. These are the pure astringents (astringentia pura). In this group are contained oak-bark and nut-galls, from the order Cupuliferae; uva ursi, from Ericaceae; catechu and logwood, from Leguminosae; rhatany, from Polygalaceae; tormentilla, from Rosaceae; the pomegranate-rind, from Myrtaceae; bistort, from
They combine both astringency and bitterness in an eminently effective form; it may, therefore, be denominated astringent bitters. It includes cinchona bark, from Cinchonaceae; spigelia, from Spigeliaceae; elm-bark, from Ulmaceae; and willow-bark, from Salicaceae. It combines the effects of both bitters and astringents, and is by far the most important group of the class, since it contains cinchona bark, the most powerful of the vegetable tonics.

d. The fourth group contains the aromatic bitters, which possess bitterness, with an aromatic flavour (derived from the presence of volatile oil), and, in some cases, astringency likewise. This group contains wormwood and elecampane, from the order Compositae; cascarrilla, from Euphorbiaceae; angustura bark, from Rutaceae; and hops, from Criciaceae. They possess the combined properties of aromatics and bitter tonics, and are, therefore, useful where these are indicated.

e. The fifth group contains the acid tonics; namely, the mineral acids, to which, perhaps, may be added alum. These, taken in the

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hilute state, allay thirst, promote the appetite and digestive process, and augment the secretion of urine. By continued use, they reduce the heat of the body, diminish the fulness and quickness, but increase the firmness of the pulse, check the cutaneous and pulmonary exhalation and secretion, and heighten the general tonicity of all the fibres and organic issues. If their employment be continued for too long a period, the digestive functions become much disturbed, chronic inflammation of the mucous lining of the alimentary canal is set up, accompanied with wasting and disorder of the whole system. They are employed as cooling and aperient means in fevers, especially of the hectic kind, and likewise as tonics. They are useful adjuncts to some of the bitter infusions.

f. The sixth group includes the metallic tonics, and consists principally of the preparations of iron. These combine tonic and stimulant properties, and will be noticed hereafter.

Active principles.—The substances contained in the vegetable tonics, and on which their activity depends, are alkaloids, crystalline substances analogous to the alkaloids, tannic and gallic acids, and extractive.

1. Tonic alkaloids.—These are quinia, cinchonia, and aricina: their properties will be examined hereafter.

2. The crystalline substances analogous to vegetable alkalies found in the vegetable tonics, and which possess medicinal activity, are salicine, centanine, quassine, &c. These are too imperfectly known to permit any general account to be given of them.

3. Tannic acid (acidum tannicum).—As this substance is employed in medicine, it will be described in a subsequent part of this work. It will be sufficient, therefore, here to state that its presence in the astringent tonics is shown by the whitish, or yellowish white precipitate, (tannoelatin) which infusions of these substances form with a solution of ringlass, and by the blue or green precipitate (pertannate of iron) which they give on the addition of a perferruginous salt. The following strongents produce a bluish black precipitate with the persalts of iron: bistort, oak-bark, nutgalls, logwood, pomegranate-rind, red rose-avens, and uva ursi. The persalts of iron give rise to a green precipitate with the barks of cinchona, willow, elm, and cinnamon, with utechu, kino, tormentilla, rhatany, and wormwood. Tannic acid usually causes precipitates (tannates) with the vegetable alkalies.

4. Gallic acid (acidum gallicum).—The properties of this acid are very similar to those of tannic acid. From this circumstance, as well as from the fact that gallic acid is easily produced by the action of air on tannic acid, it is difficult to prove whether certain vegetable substances contain both these acids, or only tannic acid. Gallic acid agrees with tannic acid in producing a deep blue colour with the persalts of iron, but it does not precipitate gelatine or the vegetable alkalies. Though obtained from several vegetables, yet it probably either does not exist in many of them, or is present in very small quantities only: it is to be regarded, in most cases, as a product rather than an educt. Thus, though nutgalls yield one-fifth of their weight of gallic acid, Pelouze thinks that, originally, they contain none of it, but that what is procured is obtained by the action of atmospheric air on the tannic acid. Taken internally, in small doses, gallic acid causes no inconvenience. It was once given in the dose from 15 to 30 grains, against the Tonia Solium, but without any
benefit. Swallowed to the extent of 24 grains, it gave rise to a sweet taste and a slight feeling of internal heat, but no other symptom.—(Dür des Drogues.)

5. Extractive.—Some of the vegetable tonics are said to owe the bitterness and medicinal activity to a principle to which the term materia hermaphrodita, materia saponacea, and extractive matter, has been applied. It is described as being of a brown colour, soluble water and alcohol, insoluble in ether, and becoming insoluble in water by long-continued boiling and by exposure to light and air. That substance, or mixture of substances, possessed of these properties, may be obtained from various plants, cannot be doubted, but it is not probable that chemists have yet succeeded in obtaining a proximate principle which the term extractive can with propriety apply. What has hitherto been procured is a mixture or compound of several principles, such vegetable acids and their combinations with potash and lime, colouring matter, sugar, gum (rendered soluble in alcohol by its combination with other substances), vegetable bases, &c.

Class 4.—Emollients.—The substances called emollients diminish the tonicity or insensible contractility of the living tissues to which they are applied, and thereby occasion local relaxation and weakness. They have an operation diametrically opposite to tonics,—especially to those which are astringent. They relax, soften, and swell the tissues, and render them more flexible. Applied to inflamed parts they diminish heat, tension, and pain, and oftentimes assist in producing the resolution of the disease; and when the inflammation is too violent, or too far advance for this to be effected, they are useful by promoting suppuration. They have a relaxing effect on the muscular fibre, and are, therefore, employed to relieve spasm. These effects have been referred by some to a physical, by others to a vital agency. During life the particles of the body are kept in approximation by two forces—attraction and the vital principle; and as emollients render the parts to which they are applied soft and flexible, that is, produce relaxation, it becomes a question whether they operate by overcoming the cohesion of the molecules or by modifying the vital properties. Most writers have regarded the action of warm water, or oil, on inorganic substances—leather, for example. But we should always be cautious in applying physical explanations to vital phenomena; and in the present instance this is particularly necessary. That emollients act on physical principles on inorganic parts of the body (the cuticle, for example) cannot be doubted, though we cannot admit this explanation in reference to living parts. Cold water diminishes the cohesion of dead parts, and renders softer and more flexible, but it has not the same effect on living tissues. Moreover, Dr. Crawford (op. cit.) ascertained that some medicinal agents diminish the cohesion of dead animal tissues, and have an opposite effect on the living tissues.

The constitutional effects of emollients are for the most part those of the nutritive, not of medicines; though the continued use of some is said to diminish the tone or vigour of the system generally—an effect ascribed by Barbier (Traité Élémentaire de Matière Médicale), to their absorptive and local action on all the fibres of the body. This statement, however, is unsupported by fact in the case of gum, starch, sugar, gelatine, and
men, and other principles, though it may hold good to a certain extent with respect to the oils.

Emollients are used to prevent the action of irritating matters on the body, by involving them, or by sheathing or defending surfaces from the action of substances capable of acting injuriously. When used for these purposes they are denominated demulcents (demulcentia, from demulceo, to mitigate or soften). Thus we administer them when acrid poisons have been swallowed. They are applied externally in the form of local baths, poultices, fomentations, &c. both as emollients and demulcents, in local inflammations, painful ulcers, &c. In irritation, inflammation, and ulceration of the alimentary canal, (as in gastritis, enteritis, diarrhoea, dysentery, &c.) they are taken either by the mouth, or in the form of clyster. In catarrh, peripneumony, and pulmonic affections in general, where the cough is dry and harsh, and the expectorated matters are acrid, the use of emollients is often attended with very beneficial effects. By their lubricating and soothing influence on the nerves distributed to the fauces, they probably affect the bronchial membrane and pulmonic structure by a reflex action. In affections of the urinary passages, as ardor urinae, emollients (especially aqueous fluids) are very serviceable.

Emollients may be arranged in the following groups:—

a. The first group contains water, the principal and most important substance of the class. In order, however, that it may act as an emollient, it must have a certain temperature; for neither very cold nor boiling water has any emollient effect. Dr. Cullen fixes 62° F. as the lowest temperature at which this fluid can be emollient; and observes, that the greater its warmth the greater will be its emollient power, provided that pain or scalding be not produced. Aqueous vapour is for two reasons more emollient than liquid water: in the first place it penetrates the organic tissues more powerfully; and, secondly, a greater degree of heat can be applied by it than by liquid water. Dr. Cullen was doubtful whether advantage could be gained by any addition made to water.

b. The second group contains the mucilaginous emollients. This group has been subdivided into the pure mucilaginous emollients (as gum arabic, tragacanth, mallow, marshmallow, &c.), the sweets (as figs), the gisters (as Cetraria islandica, coltsfoot, and sarsaparilla), and the oily (as neeseed, sweet almonds, poppy seeds, &c.)

c. The third group embraces the farinaceous or amylaceous emollients; as wheaten flour, oatmeal, barley, arrow-root, sago, tapioca, ordinary tarch, &c.

d. The fourth group consists of the saccharine emollients; as ordinary sugar, honey, liquorice, &c.

e. The fifth group includes the waxy, fatty, and oily emollients; such as the animal fats, &c. (as lard, mutton suet, butter, wax, and spermaceti), and the vegetable oils (as olive, almond, sesami, palm, poppy, linseed, &c.)

f. The sixth group contains the albuminous emollients; as the white and yolk of eggs, and milk. Saliva and gastric juice are employed on this continent for medical purposes.

g. The seventh group comprehends the gelatinous emollients; as gelatine in its pure form, isinglass, harts-horn shavings, &c.

Class 5, Refrigerants or Temperants.—Under this head are in-
eluded those medicinal agents which diminish the temperature of
the body when preternaturally increased. The only agent which in all
cases reduces animal heat is cold, used in the form of ice, cold air, cold
baths, cold lotions, cold drinks, &c. Its agency is obvious: it abstracts
heat and thereby lowers the intensity of the vital movements, diminishes va-
cular action, and reduces the calorific functions. But there are certain
medicinal substances which, by continued internal use, allay febrile heat,
and usually promote the secretions, though they have no power of dimi-
nishing the ordinary or healthy temperature, and to these the term refri-
gerant (or temperant) is usually applied. How they act is not com-
pletely understood. Dr. Murray thought they furnished oxygen to the
system, and in that way prevented so large a quantity of it being con-
sumed in the process of respiration,—an explanation borne out by the
observations of Mr. Spalding and Dr. Fyfe, that vegetable diet reduces
the consumption of oxygen gas in respiration.

Refrigerants may be arranged in the following groups:—

a. The **first group** contains the mineral and vegetable (sulphuric, hy-
drochlorie, acetic, citric, tartaric, &c.) acids, as well as the acid-
salts (alum and bitartrate of potash).

b. The **second group** includes certain neutral salts; namely, the nitrat
and chlorate of potash.

c. The **third group** comprehends certain fruits (as oranges, lemons
mulberries, tamarinds, prunes, fruit of the dog-rose, &c.), and herbs (a
wood sorrel, common sorrel, lettuce, &c.)

d. The **fourth group** comprises the animal refrigerants; as butter-milk
(lac ebutyratum), and acid whey (serum lactus acidum).

**Class 6, Evacuants.**—These are medicinal agents which provoke a
discharge by some emunctory. They are termed *vito-secerning* agents
by the late Dr. Nuttall (Lancet, vol. ix. for 1825-26, p. 578); and *vita-
agents which operate on the secerning system*, by Dr. A. T. Thomson
(*Elements of Materia Medica and Therapeutics.*)

Evacuants act by the skin (diaphoretics or sudorifics); by the mucous
membranes (errhines, expectorants, emetics, catharties, emmenagogues)
by the glands (diuretics, sialagogues).

1. **Diaphoretics or Sudorifics.**—Therapeutic agents, which promot
the cutaneous transpiration, are called either diaphoretics or sudorifics.
When the insensible perspiration is increased, they are termed *diapho-
retics* (*diaphoretica, from διαφορέω, to transpire*): when sensible perspi-
ration or sweat is augmented, they are called *sudorifics* (*sudorifica, from
sudor, sweat, and facio, I make.* But most modern physiologists regard
the insensible perspiration and the sweat as productions of the same se-
of vessels, and as differing only in their physical form: the one existing
as a vapour, the other as a liquid. In fact it is supposed that if the
cutaneous transpiration be moderate, it is converted into vapour as fast
as it is formed, and hence is termed the insensible perspiration. If
however, it be exhaled more quickly than the atmosphere can take it up,
an accumulation is the result, and it appears on the skin in the form of
drops, called sweat. Adelon (*Physiologie, tom. iii. p. 517, ed. 2nd*)
however, states that sweat contains less carbonic acid, and more salts
than the insensible perspiration; but the correctness of this assertion is
very questionable, on account of the difficulty of obtaining the insensible
perspiration for comparison, and, perhaps, from its properties varying
different times. It is highly probable that sweat differs from the insensible perspiration only in its physical form; and, assuming this view to be correct, we easily perceive that sweating may be induced in two ways; first, by increasing the cutaneous transpiration; secondly, by altering the hygrometric state of the air, so as to render this fluid less capable of olding watery vapour in solution. Hence sudorifics and diaphoretics are not essentially different: the former are generally regarded as being more powerful than the latter, or as being the same substances exhibited in larger doses. This statement, however, is not absolutely correct, inasmuch as a diaphoretic may act as a sudorific merely from a change in the hygrometric state of the air.

The most powerful means of exciting the cutaneous exhalation are,—the external application of heat, and the copious use of diluents. A variety of solid substances have been used as media for the application of heat; as hot sand, bran, ashes, earth, plaster, saline mud, dung, refuse of the grape, &c.

The hot sand bath (arena calida) is a very old remedy. Celsus (lib. i. ap. 17), Dioscorides, and Galen, speak of it. It is a powerful excitant, reddening the skin, and producing copious perspiration. Chwilgue (Traité de Matière Médicale) states that it is used in the maritime departments of the south of France. The saline mud found on the sea-shore has been employed in very hot weather, as a bath, by the inhabitants of Crimea, and especially by the Tartars, against hypochondriasis, curry, scrofula, &c. It increases the heat of the body, and excites sweat—(Bull. des Œc. Méd. de Péruvass, xiii. 179). Hot dung is sometimes used in France, as a kind of bath, against rheumatism, and by the holes against syphilis. The husk of the grape and the refuse of the olive, from which the oil has been drawn, undergo fermentation, and in this state have been successfully employed in France against acute rheumatism (Dict. de Mat. Méd.: art. Bain). Water in a liquid form, or in the state of vapour and dry air, are also used as media for the application of heat. Friction, warm clothing, exercise, and cold affusion, are among the numerous means that may have been resorted to produce diaphoresis. Most of the medicinal agents administered for the same purpose are stimulants, and, therefore, the constitutional effects (such as excitement of the vascular system, &c.) of the two classes are the same. But the excitement of the system, and the production of sweating, are not always in the same ratio; and it must be admitted that the sudorific effects of the compound powder of ipseacuana and of the antimonial preparations, considerably exceed their stimulant effects on the system generally.

The agents or means employed to produce diaphoresis are various and even opposite. In febrile complaints, when the skin is hot and dry, the best diaphoretics are cooling drinks, acids, and emollients. But in other diseases, when the skin is cold and dry, and there is great prostration of strength, unaccompanied with any local inflammation, diffusible imulants (as ammonia) are the best sudorifics. In both of these instances the agents employed are relative; that is, they remove or obviate causes which impede diaphoresis. As the substances usually denominated diaphoretics or sudorifics frequently fail to act as such, that is, increase perspiration, some writers have been led to doubt the exist-
ence of any distinct class of agents of this kind. But on the same ground the existence of several other well-established groups or classes of medicines might be denied.

I ought perhaps here to state that, by the term diaphoretic, or sudorific, I mean a substance which increases the organic or vital action of the cutaneous exhalents. This explanation is necessary, since Dr. Edwards (De l’Influence des Agens Physiques sur la Vie, Paris, 1824) has shewn that cutaneous transpiration is effected in two ways; namely, by a physical action or evaporation, and by an organic action of transudation. Evaporation, or the physical action, is the consequence of the porosity of bodies, and takes place equally in the dead and living state. It is influenced by the hygrometric states of the surrounding air by its motion or stillness, by its pressure, and by its temperature. Thus dryness, agitation, and diminution of the weight of the air, increase it. Transudation, or the organic action of transpiration, being a vital process depends essentially on causes inherent in the animal economy, although it may be influenced to a certain extent by external agents. Thus elevating the temperature of the surrounding air, preventing its frequent renewal, and covering the patient with warm clothing, are means which promote the organic, but check the physical action of transpiration.

The vital activity of the cutaneous exhalents may be promoted in one or both of two ways,—by increasing the force of the general circulation, or by exciting the cutaneous vessels. Ammonia, violent exercise, and alcohol, operate by increasing vascular action generally, while heat and friction act by exciting the cutaneous vessels. Certain medicinal agents, when swallowed, have been supposed to act as diaphoretics, by entering the blood-vessels, and stimulating the cutaneous vessels by local contact.

The operation of diaphoretics is promoted by the exhibition of large quantities of warm mild diluents, and by keeping the skin warm. Moreover, these agents are more effective when given at bed-time, since there appears to be a greater disposition to sweating during sleep than in the waking state. The exhibition of diuretics and purgatives should be avoided, as they check sweating. The older writers explained the occasional beneficial effects of sudorifics by supposing that some peculiar morbidic matter was expelled from the system, the retention of which had produced the disease; and hence sudorifics were enumerated among the Alexipharmacca and Alexiteria. But though cold, applied to the skin, may occasion disorder in some internal organ, it is more consonant with sound physiology to ascribe the internal affection to a metastasis of vital action, than to the retention of any supposititious morbidic matter; for although cold diminishes the vital or organic action of the skin (transudation) yet it does not prevent the physical action (evaporation).

Sudorifics are employed in a great variety of cases,—as catarrhal and rheumatic affections, febrile disorders, chronic diseases of the skin, &c. They are mostly indicated when the cutaneous transpiration has been suddenly checked, and some internal part (as the bronchial membrane) has become affected; also in diseases which usually or frequently terminate by sweating, as fevers.

2. Errhines (errhina, from in, and pr, the nose) are medicines
which produce an increased discharge of nasal mucus. When they excite sneezing they are called *sternutatories* (*sternulatoria* or *ptarmics* from πτάρμα, *I sneeze*).

Most foreign matters applied to the pituitary membrane promote the secretion of nasal mucus. Sugar and the labiate plants operate mildly; morphbium and white hellebore with great violence. Some kinds of snuff will, in persons unaccustomed to their use, affect the general system, giving rise to nausea, giddiness, great depression of muscular power, and slight disorder of the mental functions—effects which I have personally experienced on two or three occasions. The continued employment of snuff injures the sense of smell and alters the tone of the voice. In phthisic affections of the nose, and where there is a disposition to nasal polypi, the continued use of errhines may perhaps be injurious. Errhines have been principally employed to relieve chronic affections of the eyes, face, and brain; for example, chronic ophthalmia, naso-sinus, headache, &c. They can only be useful on the principle of counter-irritation.

Schwilgué enumerates the following purposes for which sneezing is excited: to excite respiration when this function is suspended; to promote the expulsion of foreign bodies accidentally introduced into the air-passages; to occasion a general shock at the commencement of dangerous seases which we wish at once to suppress; to augment the secretion of nasal mucus, and of tears; to favour the excretion of mucus collected in the nasal sinuses; to rouse the action of the encephalon, of the senses, the uterus, &c., and to stop a convulsive or spasmodic state of the respiratory apparatus. We should not, however, forget that the constitution occasioned by sneezing is not always free from dangerous results, especially in plethoric habits, and persons disposed to apoplexy, affected with hernia, prolapsus of the uterus, &c.

3. Sialogogues (*sialyoga*, or *sialagoqa*, from σίαλος, *the saliva*, and αὐτός, *to convey or drive out*) are medicines which excite the salivary discharge. They are of two kinds, local and remote.

α. Local sialogogues.—These are sialogogues which are applied to the mouth. When used in a soft or solid state they are called *masticatories* (*masticatoria*, from mastico, to eat or chew). They act on the mucous follicles of the mouth and the salivary glands. Most solid or fit bodies, when chewed, increase the flow of saliva; thus wax and mastic produce this effect. Acris, however, as horse-radish, mezereon, allitory of Spain, and ginger, possess this property in an eminent degree.

In almost all parts of the world masticatories are more or less used. In the East Indies betel-nuts (the seeds of Areca Catechu) are chewed, with quick lime and the betel-leaf (the leaf of Piper Betel). The Indians have a notion that these substances fasten the teeth, cleanse the gums, and cool the mouth (*Ainslie’s Materia Indica*). In this country the masticatory commonly employed by sailors is tobacco.

As the saliva is generally swallowed, masticatories do not confine their action to the mouth, but excite likewise the stomach. Peron (voyage aux Terres Australes) was convinced that he preserved his health, during a long and difficult voyage, by the habitual use of the betel; while his companions, who did not use it, died mostly of dysentery, or habitual use; and as mere sialogogues, mucilaginous and emollient
masticatories might be resorted to, but we find that acrids of various kinds have always been preferred. Masticatories, as therapeutic agents, have been principally used either as topical applications, in affections of the gums, tongue, tonsils, salivary glands, &c., or as counter-irritants in complaints of neighbouring organs, as in ear-ache, rheumatism of the pericranium, affections of the nose, &c. The stronger masticatories, as mustard and horse-radish, excite an increased discharge of nasal mucus and tears, as well as of saliva and mucus of the mouth.

β. Remote sialogogues.—Several substances have had the reputation of producing salivation or ptialism by internal use. Of these, the preparations of mercury are the only ones on which much reliance can be placed, and even they sometimes disappoint us. The preparations of gold, of antimony, and of iodine, occasionally have this effect. The continued use of the hydrocyanic or nitric acid has, in several instances, produced salivation. In poisoning by foxglove this has been observed. Lastly, nauseants increase the secretion of saliva.

Mercurials are given in certain diseases to excite ptialism, and in some cases it is necessary to keep up this effect for several weeks. It is not supposed that the salivation is the cause of the benefit derived, but it is produced in order that we may be satisfied that the constitution is sufficiently influenced by the medicine.

4. Expectorants (expectorantia) are agents which promote the expulsion of mucus and other secreted or exhaled fluids from the bronchia, trachea, and larynx. In the healthy state, the liquids secreted or exhaled by the aerian membrane are got rid of by evaporation and absorption. But when from any circumstance the balance between the two processes of production and removal is destroyed, and an accumulation of mucus takes place, nature endeavours to get rid of it by coughing. Hence some have applied the term expectorant to irritating substances (as chlorine gas, the vapour of acetic or of benzoic acid, &c.), which, when inhaled, produce coughing. “We provoke cough,” says Schwiglqué (Traité de Matière Médicale, tom. ii. p. 296), “to favour the expulsion of foreign bodies introduced from without into the aerian tube, and especially of liquids; we have recourse to it to favour the expectoration of mucus, of mucosities, of membraniform concretions, and of pus, which have accumulated in the aerian passages, whenever the local irritation is not sufficiently great.”

It has been thought by some that the mucus secreted may be too tough and viscid to admit of its being easily brought up by coughing, and the term expectorant has been applied to those medicines which have been supposed to render it thinner and less viscid. But as Mr. Moore (An Essay on the Materia Medica, 1792) has justly observed, thick phlegm is sometimes more easily expectorated than thin; and if this were not the case, we have no specific means of rendering the phlegm either thicker or thinner. Frequently the term expectorant is applied to substances supposed to increase or promote the secretion of bronchial mucus, and in pharmacological works a long list of medicines, thought to have this effect, is usually given. Most of the agents employed with this view act relatively,—that is, they obviate the causes which checked the healthy secretion. Some are topical agents, as various gases and vapours. There are others, however, which, when taken internally, are supposed to affect the aerian membrane in a specific manner, and are
neficially employed in chronic catarrhs. Such are the balsams, the resins, the cataplasms, squills, &c. Many of the substances which in chronic pulmonary complaints do not promote, but check, the secretion of bronchial mucus; as the sulphate of zinc,—to which Begin (Traité de Thérap. t. ii. p. 561) adds the balsams. Yet these agents are usually classed with expectorants. Dr. Paris (Pharmacologia) makes one class of expectorants to consist of "medicines which diminish the inordinate flow of fluid into the lungs, and render the expectoration of the remainder more easy."

Most of the substances usually denominated expectorants possess stimulating properties. Some of them become absorbed and act on the bronchial membrane by local contact. They are principally employed in bronchial catarrhs.

6. Emetics (emetica, from ἐμεῖν, I vomit,) are medicinal agents used for the purpose of provoking vomiting. They are sometimes called vomits mitioria.

(Usually within twenty or thirty minutes after taking an emetic, a general feeling of uneasiness and of nausea comes on. The pulse becomes full, feeble, and irregular; the face and lips grow pale, a sensation of axation and coldness of the whole system is experienced, the saliva is secreted copiously from the mouth, the eyes lose their lustre, and the whole countenance appears dejected. These symptoms, which constitute the first stage of vomiting, continue for a variable period, and are followed by the ejection of the contents of the stomach. As soon as actual vomiting commences, the general phenomena are altered: the pulse becomes frequent and full, the temperature of the body increases, and a sweat breaks out on the face and other parts of the body. During the act of vomiting, the consequences of the pressure made on the abdominal aorta, and the interposition of the stomach to the circulation through the lungs, from the impeded inspiration, the blood returns with difficulty from the head, the face turns and becomes coloured, the conjunctiva is turgid and red, the hepatic veins are gorged, and tears burst from the eyes. The violent hiccoughing is often attended with pain in the head and eyes, and with the voluntary expulsion of the urine and faeces. The matters vomited vary according to circumstances; they may consist of the alimentary and other substances contained in the stomach previous to the exhibition of the emetic; of the fluids collected by the action of the emetic; and, lastly, of the emetic itself. Sometimes striae of blood are observed, which usually come from the pharynx. The number of vomitings, and the cases in which they are effected, are liable to considerable variation, arising in the state of the digestive organs, the temperament of the patient, the age of the cerebral functions, &c. When the vomiting has entirely ceased, the patient feels languid, oppressed, and drowsy, and the pulse becomes weak and slow: the exhaustion is sometimes so great as to be ended with fatal consequences. A case of this kind is alluded to by Paris (Pharmacologia) in which an emetic was imprudently given to a patient in the last stage of phthisis, with the intention of dislodging the mucus from the lungs: syncope was produced, in which the patient never recovered. Among other occasional ill consequences of vomiting may be mentioned comatose affections, uterine hemorrhages, hernia, abortion, suffocation, prolapsus of the anus, rupture of the abdominal muscles, &c.
The intensity and duration of the different stages of vomiting have a necessary relation to each other. Thus the sulphates of zinc and copper excite speedy vomiting, with but little nausea;—and are, therefore, preferred as emetics in narcotic poisoning. Tobacco and tartarized antimony, on the other hand, produce great nausea and depression system.

The causes of vomiting are various. One is, suddenly distending the stomach with warm water or demulcent liquids. In cases of corrosive irritant poisoning, we adopt this method of exciting or promoting vomiting in preference to the use of acrid substances. Another method of provoking vomiting is tickling the fauces with the finger or a feather; this has been shewn by Dr. M. Hall to be a beautiful instance of reflex action. We adopt this plan in cases of poisoning until the ordinary emetics can be procured,—also in dyspepsia and cardialgia, arising from the presence of undigested food in the stomach. Acids and irritants of all kinds likewise excite vomiting when swallowed. The gamboge, mustard, common salt, euphorbium, the mineral acids, &c, have this effect when taken in large or poisonous doses. Most of these, however, are dangerous agents, and, with the exception of mustard and common salt, are not given as emetics. The last-mentioned substance are administered to excite vomiting in cases of narcotic poisoning, in malignant cholera, &c. But there are certain irritants (such as tartar emetic and ipecacuanha) which seem to have some specific power of provoking vomiting, since they produce this effect when applied to any part of the body, or when injected into the veins. These are the agents to which the term emetic is more usually applied.

Besides the above, there are many other causes of vomiting, such as acute pain, injuries of the brain, calculi in the kidneys, disagreeable odours, the sight of disgusting objects, whirling, sailing, or swelling, &c.

The irritation produced by the exhibition of emetics gives rise to a increased secretion from the mucous follicles of the stomach and duodenum; as is apparently shewn by the thick, filamentous, and viscid matters frequently ejected. We infer, also, that the action of the exhauling vessels must be increased, insomuch as persons who have taken only a few spoonfuls of emetic liquids sometimes bring up a very considerable quantity of water. Darwin mentions a man who vomited six pints of liquid, although he had only swallowed one. Bile is frequently thrown up, either alone or mixed with other fluids; but we must not infer from this that it had existed in the stomach previous to the exhibition of the emetic, for bile is not ordinarily rejected in the first efforts, but only in the subsequent vomittings; and the quantity increases in proportion to the length of time the vomiting continues. It is generally supposed that emetics promote the secretion of bile and of putrefactive juices.

6. Carthartics or Purgatives.—These are medicinal agents which excite alvine evacuations. They do so by increasing the peristaltic motion of the alimentary canal, and by promoting secretion and exhalation from the mucous lining. It has been supposed that some of them stimulate the muscular coat of the intestine, without increasing the secretions, and, vice versa, that others stimulate the mucous follicles and exhalin.
Physiological Classes of Medicines.

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Bile, thereby occasioning a copious evacuation by stool, without such increase of peristaltic motion. But all purgatives act in both ways, though sometimes very unequally so:—some affecting the peristaltic motion principally,—others, the secretions and exhalations. Those at excite watery discharges are called hydragogues; as elaterium, gamboge, and jalap. Certain purgatives do not equally affect all portions of the canal. Thus colocynth, gamboge, black hellebore, and oes, principally influence the large intestine. The acrid purgatives promote the secretion of bile and of pancreatic fluid, by the irritation they produce at the termination of the ductus choledochus.

Most if not all cathartics are local irritants, and, in some instances, the purgative operation seems to depend solely on this, as in the case of gamboge. But several others have, in addition, a specific influence over the alimentary canal, shewn by the fact that they purge even when applied to wounds or injected into the veins; as in the case of castor oil, manna, hellebore, &c.

Several purgatives become absorbed. Thus the particles of gamboge, rhubarb, sulphate of potash; and oil of turpentine, have been detected in the blood:—senna, rhubarb, and jalap, have communicated purgative properties to the milk:—lastly, cassia pulp, rhubarb, senna, and gamboge, have been recognised in the urine.

Cathartics may be arranged in groups, as follow:—

a. The first group contains the mild cathartics, denominated laxatives or lenitives; viz. manna, cassia pulp, tamarinds, prunes, honey, bitartrate of potash, and the fixed oils (as castor, almond, and olive oils). These act gently evacuate the contents of the intestinal canal, and usually without causing any obvious irritation, or affecting the general system. Manna, however, is apt to occasion flatulence and griping. Laxatives employed in any cases where we wish to evacuate the bowels with the least possible irritation, as in children and pregnant women, in persons afflicted with inflammation of any of the abdominal or pelvic viscera, with hemia, prolapsus of the womb or rectum, piles, or stricture of the duodenal canal, and after surgical operations about the abdomen and pelvis.

b. The second group is composed of the saline or antiphlogistic purgatives, such as the sulphates of soda, potash, and magnesia. They increase the peristaltic motion of the alimentary canal, and augment the emission of fluids by the exhalents of the mucous surface, thereby giving rise to watery stools. They do not appear to possess the power of taming the intestinal tube, nor of heating the general system. They are adapted for febrile disorders, inflammatory affections, plethoric conditions, &c.

c. The third group includes the milder acrid purgatives, such as senna, rhubarb, and aloes. These are more active substances than any of those mentioned in the preceding groups. They are acrids and stimulants, their local action is not sufficiently violent to cause inflammation. Manna is employed where we want an active though not very acrid or violent purgative. Rhubarb is administered in relaxed and debilitated conditions of the alimentary canal. Aloes is used in torpid conditions of large intestines, and in affections of the head. It is objectionable in cases and diseases of the rectum.

d. The fourth group comprehends the strong acrid or drastic purgatives; such as jalap, scammony, black hellebore, gamboge, croton oil,
colocynth, and elaterium. These, when swallowed in large doses, act as acrid poisons. They are employed as purgatives in torpid conditions of the bowels; as hydragogues in dropsical affections, and as counter-irritants in affections of the brain. They are objectionable remedies in inflammatory and irritable conditions of the alimentary canal.

e. The **fifth group** contains the mercurial purgatives; as the hydrant gyrum cum creta, the pilula hydrargyri, and calomel. We employ them as alternative purgatives, and to promote the hepatic functions, if they are uncertain in their operation, they are usually combined with or followed by, other purgatives.

7. **Cholagogues**.—These are medicines which increase the evacuation of bile. It is probable that most, if not all, drastic purgatives increase the secretion and excretion both of bile and pancreatic juice, by irritating the opening of the ductus choledochus in the duodenum, just as certain substances taken into the mouth provoke an increased discharge of saliva by irritating the mouths of the salivary ducts. Graaf (quoted by Barbie: Traité Elément. de Mat. Méd. tom. iii. p. 125, ed. 2nde) says, that if a purgative be administered to a dog, and when it is beginning to operate, the abdomen be laid open, the bile and pancreatic juice will be observed flowing into the duodenum.

When we consider the peculiarities attending the hepatic circulation and that all the remedial agents whose particles are absorbed have to pass through the portal vein,—the vein by whose branches the bile is secreted,—our astonishment is great that this secretion is not more frequently affected by the various medicinal agents put into the stomach. I have already mentioned (p. 152) the different substances which have been detected in the blood of either the portal vein, or of veins (splenic and mesenteric) opening into it. The branches of this vein which ramify between the lobules of which the liver is principally made up, are denominated by Mr. Kiernan (Philos. Trans. for 1833) **interlobular veins** their minuter ramifications within the lobules are called **lobular venous plexuses**, and these last insinuate themselves towards the centre with the **intrahepatic venous plexuses**. The cirrhotic veins, seen between the branches of the plexuses, are occupied by portions of the biliary plexuses, constituting the aëni of Malpighi.

d d d. The intralobular branches of the hepatic veins, in which the vessels of the plexuses terminate.

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**Representing the interlobular branches of the portal vein, the lobular venous plexuses, and the intralobular branches of the hepatic veins of three lobules.**

- a a a. The interlobular veins contained in the spaces.
- b b b. The interlobular veins which occupy the fissures, and which, with the veins of the spaces, form venous circles around the lobules. This is the appearance which the venous circles present when examined with a common magnifying glass; they are, however, formed by numerous, and not by single, branches, as represented in the figure.
- c c c. The lobular venous plexuses, the branches of which, communicating with each other by intermediate vessels, terminate in the intralobular veins. The circular and ovoid spaces, seen between the branches of the plexuses, are occupied by portions of the biliary plexuses, constituting the aëni of Malpighi.
- d d d. The intralobular branches of the hepatic veins, in which the vessels of the plexuses terminate.
The intralobular veins open into the sublobular veins around which the lobules are arranged, and when a longitudinal section is made, these lobules present a foliated appearance. The sublobular veins unite into larger branches, called hepatico-venous trunks.

Such, then, is the course taken by medicinal agents in order to reach the hepatic vein, and by this the vena cava. Now the lobular plexuses of the portal vein are accompanied by ducts to carry away the bile as it is secreted.

But notwithstanding the many substances which must ramify through the veins of the liver, only three or four have, in modern times, been posed to exercise any specific influence in promoting the biliary secretion: these are mercurials, aloes, and rhubarb. How far these serve the appellation of cholagogues will be better examined when we see them individually.

Diuretics.—These are medicines which promote the secretion of urine. They have derived their name from ἐκαί, through; ὀιωφρ, the urine; ἀπεκ, I flow. There are two principal modes of promoting the secretion of urine; one direct, the other indirect. The indirect method consists in augmenting the quantity of fluids taken into the stomach, or in removing cause which checks the secretion. The direct mode is to stimulate the kidneys by means which specifically affect these organs. These are the diuretics, properly so called. But almost all the sub-
stances thus denominated are most inconstant in their effects; much so, indeed, that some persons have doubted whether there are any agents which ought to be so designated.

The quantity of urine secreted in the healthy state is liable to considerable variation. Temperature, season of the year, climate, and time of day, are among the common circumstances modifying this secretion. Whenever an unusual quantity of aqueous fluid is taken into the system, the kidneys are the organs by means of which the excess is got rid of. If the customary discharge from the skin or lungs be checked, by cold for instance, the kidneys endeavour to make up for the deficiency of action in the other organs. Again, if transpiration be promoted, as by external warmth, the secretion of urine is diminished. Hence when we wish to augment the renal secretion, diluents should be freely administered, and the skin kept cool.

Mr. William Alexander (Experimental Essays, Edinburgh, 1766) endeavoured to determine, as nearly as possible, the relative powers of different diuretics, and he has given the following tabular views of his results:

A Table of the different quantities of urine always discharged in an equal time; viz. from nine o'clock in the morning till two o'clock in the afternoon, when an equal quantity of the same liquid was drunk, but with different diuretics, in different quantities, dissolved in it.

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<td>By lbj. 3viijss. simple infusion of bohea tea, standard,</td>
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<td>By do. with 3ij. of salt of tartar</td>
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<td>By do. • 3ij. of nitre</td>
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<td>By do. • 4 drops oil of juniper</td>
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<td>By do. • 3ij. salt of wormwood</td>
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<td>By do. • 3ij. Castile soap</td>
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<td>By do. • a teaspoonful of spt. nitr. dule</td>
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<td>By do. • 15 drops of tinct. cantharides</td>
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<td>By do. • 3ij. of sal. polychrest</td>
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<td>By do. • 3ss. of uva ursi</td>
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<td>By do. • 3ij. of magnesia alba</td>
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<td>By do. • 3ij. of cream of tartar</td>
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A Table of the different quantities of urine evacuated in the same space of time, after drinking the same quantity of different liquors.

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<td></td>
<td>By lbj. 3viijss. of weak punch, with acid</td>
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<td>By do. • new cow whey</td>
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<td></td>
<td>By do. • decoct. diuret. Pharm. Edin.</td>
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<td>By do. • London porter</td>
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<td>By do. • decoct. bardan. Pharm. Edin.</td>
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<td>By do. • warm water gruel</td>
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<td>By do. • small beer</td>
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<td>By do. • warm new milk</td>
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These tables are to a certain extent useful, but as diuretics act very unequally at different times, and cannot, therefore, be relied on, the value of Mr. Alexander's experiments is considerably diminished.

At pages 14 and 15 of this volume I have given a list of the substances which pass off by the urine. Many of these, especially the salts, stimulate the kidneys:—they do this probably by a local action in their passage through the renal vessels. Several of the vegetable diuretics owe their activity to volatile oil: such are, copaiva, the turpentine, juniper, and oil of cajuput. The oil probably acts on the kidneys by local contact, after its absorption. The modus operandi of squills and colchicum may, perhaps, be similar: that is, their active principles may
ss into the blood, and act on the kidneys in their passage through
these organs.

9. **Emmenagogues** (emmenagoga, from ἐμμενάγω, the menstrual dis-
charge, and ἀγω, to lead or convey), are agents supposed to have the
property of exciting the catamenia. As the suppression or retention
of this discharge may be occasioned by very different circumstances,
one agent can be expected to prove emmenagogue in all or even
many cases. Deficient menstruation is rarely, perhaps, an idiopathic
sease, but usually a morbid symptom merely; and, therefore, those
agents which remove it must be relative,—that is, must have reference to
the disease which produces it. Thus when deficient menstruation is
connected with a deficiency of power in the system, tonics and stimu-
lates are the best remedies. Again, in plethoric habits blood-letting
and other debilitating agents are those most likely to be serviceable.

But the term emmenagogue is usually employed in a more limited
use, to indicate those substances which are supposed to possess a
specific power of affecting the uterus and of promoting the catamenial
discharge. There are, however, few bodies to which this definition can
strictly applied. Indeed, two reasons have led some pharmacological
writers to doubt the existence of any medicines which can be properly
named specific emmenagogues, namely, the uncertainty of all the means
named, and the uterus not being an organ intended for the excretion
of foreign matters.

The substances usually regarded as specific emmenagogues are, for
most part, medicines which, when taken in large doses, act as drastic
negatives, or which stimulate the urinary organs in a very marked man-
ner. Such are savin, black hellebore, aloes, gamboge, cantharides, &c.
They excite the pelvic circulation, give rise to a sensation of bearing
down of the womb, especially in females disposed to procidentia uteri,
increase uterine haemorrhage, or the menstrual discharge, when given
under these conditions,—and when administered in chlorosis or amenor-
hea, sometimes bring on the catamenia.

The only agent possessing an unequivocal specific influence over
uterus is the ergot of rye. But this agent seems rather to promote
irregular contractions than the menstrual function,—though it has on
many occasions been successfully employed in amenorrhœa.

**Class 7. Abortiva seu Acceleratores Partus.**—These are agents
which increase the parturient efforts of the womb. At present, however,
by one substance is known which possesses this property, and that is
er
got of rye, which will be spoken of hereafter.

**Class 8. Caustics** (caustica, from καίω, I burn).—These bodies
organise by a chemical action. They are sometimes termed poten-

tiales cauteries (cateria potentialia), to distinguish them from fire or
actual cauteries. The stronger caustics, as potassa fusa, have been
named escharotics or erodents; while the milder ones, as sulphate of

copper, have been denominated catheretics or cauterns.

The following substances are those usually employed as caustics:—

1. **Strong acids** (sulphuric, nitric, hydrochloric, phosphoric, and acetic),
alkaline substances (potash, soda, ammonia, and lime), and various

tonic preparations (as the nitrate of silver, chloride of antimony, sul-

fate, and acetate of copper, chloruret of zinc, binoxide, and bichloruret

mural, and arsenious acid.) Some of these become absorbed, and
thereby affect remote parts; such are arsenious acid, and the bichloride of mercury.

Caustics are employed for various purposes, the principal of which are the following:—to remove exerescences or morbid growths of various kinds, such as warts, condylomata, some kinds of polypi, and spongiform granulations; to decompose the virus of rabid animals and the venom of the viper, and other poisonous serpents; to form artificial ulcers, as issues; to open abscesses; for the cure of hydrocele they have been applied to the serotum, so as to penetrate through the tunica vaginalis; to change the condition of ulcerated and other surfaces; lastly, caustics are applied to strictures of the urethra.

Class 9. Rubefacients, Vesicants, and Suppurants.—These are agents which, when applied to the skin, cause redness, and sometimes vesication and suppuration. The milder ones, such as friction and warm fomentations, stimulate the skin temporarily, without producing actual inflammation. The stronger ones, such as mustard and caustic soda, excite active inflammation. Those that cause the exhalation of a thin serous fluid beneath the cuticle are called vesicants or epispastic mustard, euphorbium, mezereon, acetic acid, ammonia, and cantharides are of this kind; while tartar emetic, and some other substances which produce a secretion of pus, are denominated suppurants. The medicine of this class are employed as counter-irritant in various diseases. Their general mode of operation has been before investigated (p. 45, et seq.)

Class 10. Acids.—The mineral acids, in a concentrated state, are powerful caustics; and, when swallowed, act as corrosive poisons somewhat diluted and applied to the skin, they produce rubefaction. Administered internally, in moderate doses, they act as tonics, refrigerants, and diuretics; but by long-continued use they disorder digestion, and produce emaciation. When, from any cause—such as disorder of digestion, particular kinds of food, or improper medicines—white sand (either phosphate of lime or phosphate of ammonia and magnesia, appears in the urine, the internal use of acids will, in most cases, diminish or remove it. They are improper, however, when there is much irritation in the urinary organs.—[For further observations on the modus operandi of the acids, see page 9.]

Class 11. Alkalies.—Applied in a concentrated form, the alkaline substances act as powerful caustics, and, when swallowed, become corrosive poisons. Somewhat diluted and applied to the skin, they are rubefacients. Taken internally they neutralize any acid which may be found in the stomach, and hence have been termed antacids (antiacida), or absorbents (absorbentia), and usually operate, when exhibited in moderate doses, as diuretics. By continued use they disorder digestion, render the urine alkaline, produce general debility, and give rise to symptoms similar to scorbutus. In such cases it is said that the blood drawn from a vein does not coagulate on cooling, but remains in a liquid state; and that if the use of the medicine be suspended, the blood again acquires its power of coagulation. By the continued administration of alkaline medicines the urine loses its acid properties, and occasionally becomes decidedly alkaline; and, in such cases, white sand (the phosphates) is usually deposited: hence, where a phosphatic diathesis already exists, these substances are highly improper. On the contrary, when the urine contains a larger portion than usual of uric acid, the use of alkalies is highly beneficial.
Special Pharmacology (Pharmacologia specialis) treats of medicines individually.

Natural-Historical Classification of Medicines.—Having previously stated that the natural-historical order will be followed in describing the different substances composing the Materia Medica, it will not, I conceive, be out of place to offer a few general remarks on the division of natural bodies into kingdoms, and on the characteristics of these kingdoms.

Natural bodies were formerly divided into three groups, called kingdoms—the mineral, the vegetable, and the animal; but this division has, of late years, been for the most part given up, on account of the impossibility of so characterizing the two latter as to distinguish them from each other. To obviate this difficulty the two have been formed into one, under the name of the organized or living kingdom, while the mineral kingdom, now called, in contradistinction, the inorganized kingdom.

But it has been asserted that no real distinction exists between the organized and the inorganized kingdoms. There is an order of animals called, on account of their supposed resemblance to a mass of mineral matter, the Lithozoa, or stone-animals (Goldfuss, Grundriss der Zoologie.) These skeletons are external, or eutaneous, and consist of carbonate of lime (sometimes with a little phosphate) agglutinated by gelatinous matter. These beings have been supposed to connect the animal with the mineral kingdom. But the calcareous masses of the Lithozoa are mostly porous, and in the recent state contain fleshy tubes, constituting the soft parts of the animal: a structure nothing analogous to which is found in the mineral kingdom. In the Nullipora (a family of the order Lithozoa) the pores are not evident, and hence these masses have been supposed to form the nearest relation to minerals.

Vegetables also have been stated to be closely related to animals. Here is a drawing of the Diatoma vulgaris (Fig. 31), a little vegetable of the family Algae: it varies in its form, and in the mode of connexion of its parts. At one period of its existence it is cylindrical, at another it is composed of quadrangular segments; sometimes connected by their sides, at others by their alternate angles. It will be observed that these segments have somewhat the forms and appearance of crystals; and Agardh has, in consequence, fancied they form a distinct passage from vegetables to minerals; but their active properties, and the changes they undergo at the different periods of their existence, sufficiently distinguish them.

Some zoologists (as Goldfuss) admit an order of animals which they call Phytzoza, or the vegetable-animals, (as Spongia) and which includes all those animals which resemble plants. In some cases animals resemble flowers
in their appearance; as the Actinia, or Sea Anemones (Fig. 32.) On the other hand, vegetables oftentimes exhibit a close relation, in their external appearances, to animals. The genus Oscillaria (of the family Algae) has a cylindrical form analogous to the common earth worm (Lumbricus terrestris), and presents a jointed appearance, from the junction of the segments composing its interior tube. Now, individuals of this genus are endowed with the power of motion as if voluntary, like animals. Tendaridea Pollux (Fig. 33) is an example of the tribe of plants called Conjugate, the individuals of which perform some acts analogous to those of animals. Two tubes approach each other, and become connected: we then observe that the green-colouring matter (which in each has a star-like form) passes from the joint of one into the joint of the other, and forms there a roundish gemmiform body, which subsequently becomes a new being. In the Zoocarpeae we have beings in which the vegetable and animal states appear to succeed each other. In Anthophysis dichotoma (Fig. 34) the tubular filaments produce, at their extremities, little globules, which when detached from their support, possess a locomotive power and (according to Bory St. Vincent) become a multitude of Zoocarpeae, or animated monads.

The accompanying diagram will explain in what way it has been supposed the mineral, vegetable, and animal groups approach each other:—
The organized and inorganized kingdoms are distinguished from each other by peculiarities of chemical composition, of form and structure, and of actions or functions.

1. Peculiarities of Chemical Composition.

Inorganized Bodies.

1. The undecomposed or elementary substances are fifty-four in number,—namely, oxygen, chlorine, bromine, iodine, boron, silicon, hydrogeu, carbon, nitrogen, phosphorus, sulphur, selenium, boron, silicon, potassium, sodium, lithium, magnesium, calcium, barium, stronium, aluminium, glauconium, zirconium, yttrium, cerium, thorium, thorium, arsenicum, antimony, chromium, vanadium, molybdenum, tungsten, columbium, tantalium, gold, silver, platinum, palladium, iridium, osmium, mercury, bismuth, copper, tin, lead, cadmium, zinc, cobalt, nickel, manganese, iron, and vanadium.

2. Are sometimes simple, or elementary; and, when compound, sometimes contain only two elements.

3. The compound atoms are capable of composition and of recomposition.

4. Are incapable of undergoing fermentation and putrefaction.

2. Peculiarities of Form and Structure.

Inorganized Bodies.

1. The volume is variable and indefinite.

2. The exterior form may be regular or irregular. When regular, these bodies are bounded by straight lines, and have angles; in other words, the regular form of inorganized bodies is crystalline.

3. The internal arrangement of the parts, or the structure, may be regular or irregular. If solid and regular, it is crystalline.

4. Are generally composed of solid, liquid, or gaseous matter, exclusively: some exceptions, however, to this statement exist. Dr. Brewster has discovered colourless and transparent liquids in some ounces, chrysoberyl, &c.

Organized Bodies.

1. The undecomposed or elementary substances are about twenty—namely, oxygen, chlorine, bromine, iodine, fluorine, hydrogen, carbon, nitrogen, phosphorus, sulphur, silicon, potassium, sodium, calcium, magnesium, aluminium, iron, manganese, gold, and copper. Of late it has been asserted that titanium is present in the renal capsules. Of the above-mentioned twenty elements in organized beings, only three or four are met with in considerable quantity—namely, oxygen, hydrogen, carbon, and nitrogen.

2. Are never simple. Every living part contains three or four elements at least, and frequently more.

3. Organised or living parts may be decomposed, but cannot be recomposed.

4. Are capable of undergoing fermentation and putrefaction.

5. The separate parts are generally homogeneous, though sometimes heterogeneous.

6. The separate parts are independent each other.

4. Always consist of both solids and fluids. Mosses and certain animals (as the Vorticella rotatoria and Vibrio Anguilla) may be dried without destroying their vitality; and hence form exceptions to this statement. But they are probably never so dried as to be wholly deprived of moisture; and, in the next place, in this dried state they give no sign of life; for it is only by moistening them that the vital phenomena become apparent. Moreover, Ehrenberg denies that animals can revive after desiccation.—(Müller's Physiol. p. 33.)

5. The separate parts are essentially heterogeneous: that is, they possess different properties.

6. The separate parts are always related, and in some cases are dependent on each other. This subserviency of one part to the other constitutes what is termed organization, the parts being called organs.
3. Peculiarities of Actions or Functions.

Inorganized Bodies.

1. Are produced by the agency of cohesion and affinity, at the expense of other previously existing bodies.

2. Are preserved or exist solely by cohesion and affinity.

3. Are in a state of rest.

4. Undergo no alterations in their nature, except such as result from the operation of attraction and repulsion.

5. Have active properties which are always the same in degree and kind.

6. Have an existence which is not necessarily limited or definite.

7. Perform actions referrible to repulsion and attraction only.

Organized Bodies.

1. Are produced by other similarly constituted bodies, which we call parents. There are, indeed, many cases in which we cannot demonstrate the existence of parent; and several arguments may be adduced in support of the doctrine of equivocal generation; but the majority of physiologists are opposed to it, and adopt as an axiom the statement of Harvey, "Omne vivum ex ore." Cohesion and affinity are insufficient to account for the production of organized beings, and hence we call to our aid another power, which we denominate "the vital force."

2. Are preserved or exist frequently in opposition to the usual operation of cohesion and affinity by the agency of "the vital force."

3. Are in a continual state of activity, taking in from the external world certain solid, liquid, and gaseous substances, as simulating them to their own proper fluids, and converting them into solids, or preparing peculiar liquids from them. These phenomena constitute the process called nutrition.

4. Are incessantly undergoing changes so that at different periods of their existence their properties are somewhat different. Thus they increase, become developed, arrive at maturity, and, lastly, decrease. The phenomena of age, therefore, are peculiar to organized beings.

5. Have active properties which vary in degree and kind: the distinction of health and disease which depends on this variation, is, therefore, peculiar to organized beings.

6. Exist only for a limited period. The cessation of their existence is denominated death. The oldest organized beings on our planet are probably the baobab trees (Adansonia digitata) described by Adanson; the ages of some of which have been computed to be five or six thousand years! Though there is, perhaps, great exaggeration in this calculation, yet these trees are undoubtedly very aged.

7. Present phenomena which cannot be explained by reference to attraction and repulsion merely: we, therefore, admit other properties, called vital, which we refer to life, or the vital force.
REGNUM INORGANICUM.—THE INORGANIC KINGDOM.

Order I.—Oxygen and its aqueous solution.

Oxyge'nium.—Oxy'gen.

History, synonyms, and etymology.—Oxygen gas was discovered in the 1st of August, 1774, by Dr. Priestley, who denominated it dephlogis-ticated air. In the following year, Scheele also discovered it, without knowing what Priestley had done, and he called it empyr'eal air. Concorct termed it vital air. Lavoisier called it oxygen, from (ωστρ, acid; and γενεσθαι, to engender or produce.)

Natural history.—(a.) In the inorganized kingdom.—Oxygen is, of all substances, that which is found in the largest quantity in nature, or it constitutes at least \( \frac{3}{4} \) of the known terraqueous globe. Thus, water, which covers about three-fourths of the surface of the earth, contains of its weight of oxygen; and the solid crust of our globe probably consists of at least \( \frac{1}{4} \) part, by weight, of this principle; for silica, carbonate of lime, and alumina, the three most abundant constituents of the earth's strata, contain nearly half their weight of oxygen. Mr. De la Reece (Researches in Theoretical Geology, p. 8) calculates that silica alone constitutes "forty-five per cent. of the mineral crust of our globe." of the atmosphere, oxygen constitutes 20 or 21 per cent. by volume, or about 23 per cent. by weight, to which must be added \( \frac{1}{2} \), by weight, of the atmospheric aqueous vapour.

(b.) In the organized kingdom.—Oxygen is an essential constituent of all living bodies. Vegetables, in the sun's rays, absorb carbonic acid and decompose it, retain the carbon, and emit the oxyge'n. Hence they have been supposed to be the purifiers of the atmosphere.

Preparation.—There are several methods of procuring this gas, but shall notice three only:—

1. By heating chlorate of potash in a glass retort.—This method yields pure oxygen gas. One equivalent, or 124 parts of chlorate of potash, yield six equivalents or 48 parts of oxygen, and one equivalent or 76 parts of chloride of potassium.

<table>
<thead>
<tr>
<th>Substances used.</th>
<th>Results.</th>
</tr>
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<tbody>
<tr>
<td>1 eq. Chlorate Potash, 124</td>
<td>6 eq. Oxygen ... 48</td>
</tr>
<tr>
<td>5 eq. Oxy. 40</td>
<td>1 eq. Chlor. 36</td>
</tr>
<tr>
<td>1 eq. Oxy. 8</td>
<td>1 eq. Potas. 40</td>
</tr>
<tr>
<td>1 eq. Potas. 48</td>
<td>1 eq. Chloride Potas. 76</td>
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</table>

2. By heating binoxide of manganese in an iron bottle.—This is the cheapest method, and, for ordinary purposes, it yields oxygen gas sufficiently pure. To free the gas from carbonic acid, wash it with lime-water or with a solution of caustic potash. One pound of the commercial binoxide usually yields from 30 to 40 pints of gas; but, from fine samples, 40 to 50 pints may be procured. Two equivalents or 88 parts of pure binoxide yield one equivalent or 8 parts of oxygen, and two equivalents or 80 parts of the sesquioxide of manganese.

<table>
<thead>
<tr>
<th>Substance used.</th>
<th>Results.</th>
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<tbody>
<tr>
<td>2 eq. Binoxide Manganese = 88</td>
<td>1 eq. Oxygen 8</td>
</tr>
<tr>
<td>2 eq. Sesquioxide Manganese 80</td>
<td></td>
</tr>
</tbody>
</table>
3. By heating binoxide of manganese with about its own weight of strong sulphuric acid in a glass retort.—The quantity of acid to be employed should be sufficient to form with the binoxide a mixture having the consistence of cream. This method is followed only when an iron bottle cannot be procured, or when a small quantity of gas is wanted at a very short notice. One equivalent, or 44 parts, of the binoxide, yields one equivalent or 8 parts of oxygen, and one equivalent or 36 parts of the protoxide of manganese: the latter substance forms, with an equivalent or 40 parts of anhydrous sulphuric acid, one equivalent or 76 parts of sulphate of the protoxide of manganese.

**Substances Used.**

<table>
<thead>
<tr>
<th>1 eq. Binox. Mang.</th>
<th>44</th>
<th>1 eq. Oxygen 8</th>
<th>1 eq. Oxygen 8</th>
</tr>
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**Results.**

Properties.—It is elastic, colourless, odourless, tasteless, incombustible, but a supporter of combustion. According to Dr. Thomson, 100 cubic inches of this gas weigh, at the temperature of 60° Fah., and when the barometer stands at 30 inches, 34·60 grains; hence its specific gravity is 1·111. According to Berzelius and Dulong, the spee. grav. is 1·1026. Its atomic weight is 8: its atomic volume 0·5, hydrogen being in both cases unity.

**Characteristics.**—If a taper or match be plunged into this gas after the flame has been blown out, but while the wick or charcoal is yet glowing, the flame is instantly reproduced. The only gas likely to be confounded with oxygen in this respect is the protoxide of nitrogen, from which oxygen is distinguished by exploding it with hydrogen. A mixture of one volume oxygen and two volumes hydrogen, yields, by explosion, water only, whereas a mixture of one volume of the protoxide of nitrogen with one volume hydrogen, yields water and one volume of nitrogen.

**Physiological Effects.**—(a) On vegetables.—Oxygen gas is essential to the germination of seeds, and to the existence and growth of plants. In the shade vegetables absorb it from the atmosphere, and evolve an equal volume of carbonic acid; while in the solar rays the reverse changes take place; carbonic acid being absorbed and oxygen expired. The vigorous growth of plants in inclosed cases, as originally proposed and practised by my friend Mr. N. B. Ward (Companion to the Botanical Magazine for May, 1836), does not invalidate the above statements; since the cases are never completely air-tight, but allow the ingress and egress of air consequent on changes of temperature.

The effects of pure oxygen gas on germination and vegetation have been examined by Theod. de Saussure (Recherches Chimiques sur la Végétation, 1804). He found that the period of germination is the same in oxygen gas as in atmospheric air, but that seeds evolve more carbonic acid in the former than in the latter (pp. 11 and 12). Plants do not thrive so well in an atmosphere of oxygen gas in the shade as in one of common air; they give out more carbonic acid, which is always injurious to vegetation in the shade. When exposed in oxygen gas to the direct rays of the sun, they augment in weight about as much as in atmospheric air (p. 93, op. cit.).
(b) On animals generally.—It is usually asserted that all animals require the influence of oxygen, or rather of air, to enable them to exist: at this assertion cannot be proved in the case of some of the lower animals. Thus intestinal worms seem to dispense with respiration (Hüller’s Physiology, p. 295). Some animals which respire have no organs specially devoted to this function; in these the cutaneous surface effects respiration; as in the Polypifera. In the Infusoria the respiratory organs are delicate cilia. Many animals have branchiae or gills for respiration, as some Mollusca, some Annelida, and fishes. Leeches respire by subcutaneous sacs which open externally. The respiratory organs of insects are ramifying tracheæ. Lastly, the higher classes of animals respire by means of lungs. Whenever respiration is affected a portion of oxygen disappears, while a quantity of carbonic acid, nearly equal in volume to the oxygen consumed, is produced.

The continued respiration of oxygen gas is injurious, and even fatal to animal life: this has been observed by all experimenters. Animals live longer in a given volume of oxygen than in the same quantity of atmospheric air, but the continued employment of it causes death. Mr. Broughton confined rabbits, guinea-pigs, and sparrows, in glass jars containing oxygen, and inverted over water. At first they suffered no inconvenience, but in about an hour their breathing became hurried, and the circulation accelerated. This state of excitement was followed by one of feebleness; the respirations became feeble, and were more slowly performed; loss of sensibility and of the power of voluntary motion supervened, till the only remaining visible action was a slight one of the diaphragm, occurring at distant intervals. On opening the body, the blood (both venous and arterial) was found to be of a bright scarlet hue; it was thin, and rapidly coagulated. The gas in which animals had thus been confined till they died, retained its power of rekindling a blown-out taper, and of sustaining, for a time, the life of another animal introduced into it; and Mr. Broughton hence deduced the inference that it does not contain so great an excess of carbonic acid as the gas left when animals have perished by confinement in atmospheric air, and he considered the train of symptoms induced by the respiration of pure oxygen gas as analogous to those which follow the absorption of certain poisons into the system (Medical Gazette, vol. iii. p. 775). Injected into the pleura, oxygen gas is very quickly absorbed, without producing inflammation. Carefully injected into the veins of dogs, it has no sensible effect on the system (Nysten, Recherches de Physiologie, p. 60).

(c.) Effects on man.—If pure oxygen be inspired a few times it does not produce any remarkable phenomena; though some have ascribed various effects to it, such as agreeable lightness in the chest, exhilaration, increased frequency of pulse, a sensation of warmth in the chest, gentle respiration, and an inflammatory state of system. But several of these results arise probably from mental influence, others from the mode of inhaling the gas, and perhaps some might depend on the employment of pure oxygen.

Uses.—Oxygen gas was formerly employed in medicine in certain diseases supposed to depend on a deficiency of oxygen in the system; and the beneficial results obtained by the use of acids (especially the nitric acid) of the oxides of mercury, chlorate of potash, vegetable food, &c. were referred to the oxygen which these substances contained, and
which they were supposed to communicate to the system. These notions are now exploded.

In asphyxia arising from a deficiency of atmospheric air, or from breathing noxious vapours, the inhalation of oxygen gas has been said to be, and probably is, useful. On the same principle, it may be employed during an attack of spasmodic asthma, when there is danger of suffocation, but it is at best only a palliative, and has no power of preventing the occurrence of other attacks. Chaussier has recommended its use in children apparently still-born. To combat the asphyxia of malignant cholera, inhalations of oxygen were tried in Russia, Poland, Prussia, and France, but without success (Merat and De Lens, Dict. Mat. Méd. tom. 5** p. 143).

_Aqua Oxygēnii._—Ox'ygen Water.

At the mean pressure and temperature of the atmosphere, 100 vols. of water dissolve, according to Dalton and Henry (Elem. Experim. Chem.) 3·7 vols. of oxygen gas, according to Saussure (ibid.) 6·5 vols. By pressure in a proper machine, water may be charged with a much larger quantity (Jourdan, in the Pharmacopée Universelle, says with half its volume) of gas. This solution has been termed oxygenated water, but is a very different substance to the peroxide of hydrogen, which also has been known by this appellation. It has been used to the extent of one or two bottlefuls daily, as a slight excitant. It is said to increase the appetite and promote the secretions; and to be serviceable in spasm of the stomach, amenorrhea, hysteria, atonic dropsy, &c.

**Order II.—Chlorine and its Aqueous Solution.**

_Chlorin'ium._—Chlor'ine.

**History, Synonymes, and Etymology.**—This gas was discovered by Scheele in 1774, who termed it _dephlogisticated muriatic acid._ Berthollet, in 1785, named it _oxygenated muriatic acid._ Sir H. Davy called it _chlorine_ (from _χρυσίς, green_), on account of its colour.

**Natural History.**—It is found in both kingdoms of nature. (a.) _In the inorganized kingdom_ it exists principally in combination with sodium, either dissolved in the water of the ocean or forming deposits of rock salt. Chlorine also occurs native, in combination with magnesium, calcium, lead, silver, &c. Free hydrochloric acid is met with in the neighbourhood of volcanoes, and is probably produced by the decomposition of some chloride. (b.) _In the organized kingdom_, it is found in combination, in both animals and vegetables. Sprengel (Decand. Physiol. Vég. tom. i. p. 220), says maritime plants exhale chlorine, principally during the night. Hydrochloric acid, in the free state, exists, according to Dr. Pront, in the stomach of animals during the process of digestion.

**Preparation.**—There are several methods of procuring chlorine gas:—

1. _By adding sulphuric acid to a mixture of common salt and binoxide of manganese._—This is the cheapest and most usual method of preparing it. Mix intimately three parts of dried common salt with one part of the binoxide of manganese, and introduce the mixture into a retort. Then add as much sulphuric acid, previously mixed with its own weight of water, as will form a mixture of the consistence of cream. On the
application of a gentle heat, the gas is copiously evolved, and may be
flected over either warm or cold water.
In this process two equivalents, or 80 parts of sulphuric acid, react on
the equivalent or 44 parts of the binoxide, and on one equivalent or 60
parts of chloride of sodium, and yield one equivalent or 36 parts of
chlorine, one equivalent or 76 parts of the sulphate of the protoxide of
manganese, and one equivalent or 72 parts of the sulphate of soda.

INGREDIENTS USED.
\[ \begin{align*}
\text{Chloride, Sodium} & : 60 \\
\text{Binox. Mang.} & : 44 \\
\text{Sulphuric Acid} & : 80
\end{align*} \]

PRODUCTS.
\[ \begin{align*}
\text{Chlorine} & : 36 \\
\text{Soda} & : 32 \\
\text{Sulphate Soda} & : 72 \\
\text{Protosulphate, Mang.} & : 76
\end{align*} \]

2. By heating a mixture of equal weights of common hydrochloric acid
and binoxide of manganese in a glass retort over a lamp.
In this process two equivalents or 74 parts of hydrochloric acid react
on one equivalent or 44 parts of the binoxide, and yield one equivalent or 60
parts of chlorine, one equivalent or 9 parts of water, and one equivalent
or 64 parts of protochloride of manganese.

INGREDIENTS USED.
\[ \begin{align*}
\text{Hydrochl. Acid} & : 74 \\
\text{Binox. Mang.} & : 44
\end{align*} \]

PRODUCTS.
\[ \begin{align*}
\text{Chlorine} & : 36 \\
\text{Hydrog.} & : 2 \\
\text{Water} & : 18 \\
\text{Protochlo. Mang.} & : 64
\end{align*} \]

3. By the action of hydrochloric acid on chloride of lime.—This method
may be resorted to when binoxide of manganese cannot be procured.
The products of the reaction of the ingredients are, chlorine, water, and
chloride of calcium.

Properties.—Chlorine, at ordinary temperatures and pressures, is a
viscid substance, having a yellowish green colour, a pungent, suffocating
odour, and an astringent taste. 100 cubic inches weigh between 76
and 77 grains. Its sp. gr. is, according to Dr. Thomson, 2·5. Its
ivalent by weight is 36, by volume 1 ;—hydrogen being unity.
It is not combustible, but is a supporter of combustion.
Phosphorus and powdered antimony take fire spontaneously when introduced into it,—a taper burns in it with
the evolution of a red light and much smoke. When
later is present it destroys vegetable colours, organic odours, and infe-
rious matters.

By a pressure of 4 atmospheres at the temperature of 60° F., chlorine
is a yellow liquid, having a sp. gr. of 1·33 (water being 1).

Characteristics.—The colour, odour, and bleaching property of chlo-
readily distinguish it from other gases. It forms a white curdy precipitate (chloride of silver) with the nitrate of silver: this precipitate
at once by exposure to light, from the escape of a little chlorine and the
ation of a sub-chloride of silver (Wetzlar, in Landgrebe’s Versuch
der das Licht. p. 53, 1834); is insoluble in nitric acid, readily dissolves
liquid ammonia, and when heated in a glass tube fuses, and on cooling
cretes into a gray, semi-transparent mass (horn silver or luna cornea).
Aqueous solution of chlorine dissolves leaf gold. The chlorides react
the solution of nitrate of silver as free chlorine. They evolve hydro-

chloric acid when heated with liquid sulphuric acid. If a watery solu-
tion of a chloride, coloured blue by sulphate of indigo, be submitted
the action of a galvanic battery, the chlorine is evolved at the posi-
tion (anode) and destroys the colour of the sulphate of indigo in the
neighbourhood of that pole.

The chlorates when heated evolve oxygen, and are converted in
chlorides. When mixed with strong sulphuric acid they become orange,
and give out the peroxide of chlorine. They do not precipitate tel
salts of silver.

The perchlorates evolve oxygen, and are converted into chlorides when
heated. They do not become red or give out peroxide of chlorine by the
action of sulphuric acid. The soluble perchlorates precipitate the sal
of potash.

Physiological Effects. (a) On vegetables.—The germination
seeds has been said to be promoted by watering them with a weak solution of chlorine, but the statement is probably erroneous. (Decand. Phy
Végét. t. ii. p. 632.)

b. On animals generally.—Nysten (Recherches, p. 140.) injected
small quantity of chlorine gas into the jugular vein of a dog, and the
only effect was howling. A larger quantity occasioned difficult respi-
roration, apparently great agony, and death in three minutes. The
body was opened four minutes afterwards: the blood was fluid and
venous in the auricles and ventricles, which contained neither gas nor
coagula. On another occasion he threw this gas into the pleura, and thereby produced inflammation of this membrane and death. From
these experiments, Nysten (op. cit. p. 143) concludes that it is a local
irritant, but has no specific effect on any part of the system.

c. On man.—Chlorine gas acts as a local irritant. Mr. Wallace (Re
searches respecting the Medical Powers of Chlorine, particularly
Diseases of the Liver, 1822), tells us, that diluted with air, or aqueous vapour, of 116° F., and applied to the skin, it produces peculiar sensa-
tions, similar to those caused by the bite or sting of insects: this effect
accompanied with copious perspiration, and a determination of blood
the skin, sometimes attended with an eruption of minute papulæ, or evanesceules. Applied to the skin in a pure form, its action is similar, but
more energetic.

If an attempt he made to inspire undiluted chlorine gas, it produc-
spasm of the glottis. If the gas be mixed with air, it enters into the
bronchial ramifications, causes a sensation of tightness and suffocation
and violent cough. Twice I have suffered most severely from the accidental inhalation of it; and each time it gave me the sensation of
constriction of the air-tubes, such as might be produced by a spasmotic
condition of the muscular fibres of the bronchial tubes. The attack
usually goes off in increased secretion from the mucous membrane. When
diluted with a large quantity of air, chlorine may be inhaled without
exciting cough: it occasions a sensation of warmth in the respiratory
passages, and promotes expectoration.

The irritating effects of chlorine are less powerful on those accustomed
to inhale it; as I have repeatedly seen in patients who were using the
gas, and which is also shewn by the following statement made by Dr.
Christison, (Treatise on Poisons, p. 736)—"I have been told (says he)
by a chemical manufacturer at Belfast, that his workmen can work with
impurity in an atmosphere of chlorine, where he himself could not remain above a few minutes. The constitutional or remote effect caused by inhalations of chlorine, increased frequency of the pulse and of respiration. But this effect may be in part owing to the increased muscular efforts of the patient. Dr. Wallace states that the application of chlorine to the skin also occasions soreness of the mouth, fauces, and oesophagus, increased vascularity, and even minute ulcerations of these parts, and an alteration in the quality and quantity of the salivary and biliary secretions. He thinks that it has a tranquilizing, and at the same time exciting power, with respect to the nervous system. Dr. Christison tells us that at the Belfast manufactories above alluded to, the chief consequences of exposure to an atmosphere of chlorine are acidity and other stomach complaints, which the men generally correct by taking chalk. Absorption of fat is said to be an effect observed in the manufactories at Glasgow, Manchester, and Belfast. (Cogswell’s Essay on Iodine, p. 82.) When applied to the skin or bronchial membrane, does chlorine gas become absorbed? If Mr. Wallace’s observation be correct, we must infer that it does, and that it is thrown out of the system by the kidneys; for he says the urine acquires bleaching properties.

Uses.—(a) As a fumigating agent, disinfectant, and antiseptic, chlorine, I believe, stands unrivalled. Halle, in 1785, appears to have been the first person who employed it as a disinfectant; but we are greatly indebted to Gayton-Morveau for the zeal and energy he manifested in his attempts to introduce it into use. For destroying miasma, noxious fumes, and putrid odours, it is the most powerful agent known; and is, therefore, well adapted for disinfecting prisons, ships, hospitals, dissecting-rooms, and all other places, the air of which requires purification. The best method of fumigating a large building is that adopted by Dr. Praday, at the General Penitentiary at Milbank. One part of common salt is intimately mixed with one part of the black or binoxide of manganese; then placed in a shallow earthen pan, and two parts of oil of triol, previously diluted with two parts by measure of water, poured over the whole and stirred with a stick. Chlorine continued to be liberated on this mixture for four days. The quantities of the ingredients connected were 700 lbs. of common salt, 700 lbs. of binoxide of manganese, and 1400 lbs. of sulphuric acid. The disinfecting power of chlorine is supposed to depend on its affinity for hydrogen, by which it effects the composition of water or aqueous vapour, with the hydrogen of which it fuses, while the nascent oxygen oxidizes the organic matter: or it may be merely by abstracting hydrogen from the putrid miasma.

(b) As an antidote in poisoning by hydrocyanic acid, sulphuretted hydrogen, or hydro sulphate of ammonia, chlorine gas is a very valuable agent. I believe, however, that the chloride of lime will be found a more convenient, safe, and opportune substance; of course its activity depends on the chlorine which it contains or gives out. The beneficial influence of chlorine in the treatment of animals asphyxiated by sulphuretted hydrogen, doubtless arises in part at least from its chemical properties; for when mixed with sulphuretted hydrogen, it forms chloride of sulphur and hydrochloric acid. The best method of applying the remedy is to diffuse a little chlorine in the air, and then to effect artificial respiration.

(c) Inhaled in chronic pulmonary diseases it is sometimes a useful
remedy. I have carefully watched its effects in phthisis and other chronic diseases of the lungs; and the result of my observation is, that chlorine is rarely serviceable. Frequently, after the first and second inhalation the patients fancy their breathing much relieved, while the expectoration is promoted, but the amendment is seldom permanent. I need hardly say it has no pretensions to the cure of phthisis, but it may be useful as a palliative (sometimes diminishing the sweating); and I eagerly believe that occasionally in chronic bronchitis it may be of essential service, though, I confess, I have never found it so.

I have before described the mode of administering the gas (p. 51). Either the aqueous solution of chlorine, or a small portion of the chloric of lime, may be placed into the inhaling bottle: if the latter be not sufficiently strong, a few drops of muriatic acid are to be added, to develop free chlorine.

(d.) In cases of the liver, not attended with active inflammation, M. Wallace has successfully employed baths of gaseous chlorine, either in the pure state or diluted with air or aqueous vapour. The benefit chlorine in these cases has been confirmed by others. The temperature of the bath, and the time the patient ought to remain in it, will vary in different instances; but Mr. Wallace thinks, that, in the greater number 115° Fah. will be found to answer best, and the proper time about an hour. The benefit obtained is in part referrible to the heat employed in part to the irritant effect of the chlorine on the skin, and (according to Mr. Wallace) in part to the specific influence of chlorine on the liver. Ziese, an apothecary at Altona, has also employed chlorine baths in these cases with advantage.

Antidotes.—The inhalation of ammoniaal gas, of the vapour of warm water, of spirit of wine, or of ether, has been recommended, to relieve the effects of chlorine. I tried them all when suffering myself, but without the least apparent benefit. In a case related by Kastner, and which reported in Wibmer's work (Die Wirkung der Arznei. u. Gifte. 2. p. 4, p. 109), sulphuretted hydrogen gave great relief. If this agent be employed, it must be done cautiously, as it is itself a powerful poison.

A'qua Chlorin'ii.—Chlo'rine Water.—Ph. Dub.

History.—This compound has been known by the various names liquid oxymuriatic acid, aqua oxymuriatica, and liquor chlori. In the Dublin Pharmacopoeia it is termed aqua chlorinii, or chlorine water.

Preparation.—In the Dublin Pharmacopoeia this compound is prepared as follows:—add 87 parts of sulphuric acid to 124 parts of water, when the mixture has become cold, pour it on a mixture of 100 parts dried common salt, intimately mixed with 80 parts of binoxide of manganese, and placed in a retort. Transmit the gas which is evolved on the application of a moderate heat, through 200 parts of water, placed in Woolfe's bottle: but in the absence of this a wide-mouthed bottle close by a cork with two perforations, through which pass two glass tubes, but dipping into the water, but one of which communicates with the retort. A Florence flask, to which a enrobed tube is adapted by means of a cork, a more convenient vessel for generating the gas in, than a retort.

Properties.—At the temperature of 60° F. and common pressure of the atmosphere, water takes up about twice its bulk of the gas (Gay-Lussac.
Physiological Effects.—In a concentrated form, the aqueous solution of chlorine acts as a corrosive poison. Somewhat diluted it ceases to be a rustie, but is a powerful local irritant. Administered in proper doses, and sufficiently diluted, it acts as a tonic and stimulant. The continued use of it is said to have caused salivation. Applied to dead organic matter it operates as an antiseptic and disinfectant.

Uses.—Chlorine water has been employed in medicine both as an external and internal remedy.

(a.) Externally.—It has been used in the concentrated form as a caustic, applied to wounds caused by rabid animals; diluted, it has been employed as a wash in skin diseases, namely, in the itch and porrigo; as gargle in putrid sore-throat; as a local bath in liver diseases; and as an application to cancerous and other ulcers attended with a fetid discharge. In the latter cases I have repeatedly employed it with advantage, though I give the preference to a solution of the chloride of soda.

(b.) Internally.—It has been administered in those diseases denominated putrid; for example, in the worst forms of typhus, in scarlet fever, and in malignant sore throat. It has also been employed in venerealadies, and in diseases of the liver.

Dose.—The dose of this solution varies with the degree of concentration. I have frequently allowed patients to drink, ad libitum, water, to which some of this solution has been added. If made according to the receipts of the Dublin Pharmacopoeia, the dose is from one to two rachms properly diluted.

Antidotes.—According to Devergie, the antidote for poisoning by a solution of chlorine is albumen. The white of egg, mixed with water and milk (the caseum of which is as effective as the albumen of the egg) to be given in large quantities. The compound which albumen forms with chlorine has little or no action on the animal economy, and may be avidly expelled from the stomach. In the absence of eggs or milk, flour might be exhibited: or if this cannot be procured, magnesia or chalk. The gastro-enteritic symptoms are, of course, to be combated in the usual way.

Order III.—Iodine.

Iodin'ium.—I'odine.

General History.—Iodine was discovered in 1811 by M. Courtois, a tulipetre manufacturer at Paris. It was first described by Clement in 1813, but was afterwards more fully investigated by Davy and Gay-Lussac. It was named Iodine, from iode, violet-coloured, on account of the colour of its vapour.
Natural History.—It exists in both kingdoms of nature.

(a.) In the inorganized kingdom.—Vauquelin met with iodide of silver in a mineral brought from Mexico, and Mentzel found iodine in an ore zinc which contained cadmium. It has also been met with in an ore lead—(Journ. de Pharmacie, tom. xxiii. for 1837, p. 29.) In sea-water has also been discovered, where it probably exists as an iodide of sodium or of magnesium. Many mineral waters likewise contain it. It was detected by Mr. Copeland in the carbonated chalybeate of Bonnington. About one grain of iodine was found by Mr. Daubeney in ten gallons of the water of Robbin’s Well at Leamington, in Warwickshire. In the other well at Cheltenham the quantity was not more than one grain in six gallons. In a brine-spring at Nantwich, in Cheshire, there was about one grain of iodine in twelve gallons. In the sulphurous water of Cast Nuovo d’Asti, iodine was discovered by Cantu. In some of the mineral waters of Germany, Bavaria, and South America, it has also been detected—(Gairdner on Mineral and Thermal Springs, p. 27.) Fuel found it in the rock-salt of the Tyrol—(Gmelin, Handbuch der Chemie.)

(b.) In the organized kingdom.—Of animals containing iodine I may mention the genera Spongia, Gorgonia, Doris, and Venus: likewise Sepia the envelopes of the eggs of which contain it. An insect has been found near Ascoli, in Italy, which Savi has described under the name of Julefamidissimus, containing iodine. The animal emits, when disturbed, yellow fluid strongly smelling of iodine, and which immediately strikes the characteristic violet colour with starch—(British and Foreign Medical Review for January, 1838, p. 163.) Recently iodine has been detected in the oil of the cod’s liver—(Journ. Pharm. tom. xxiii. p. 501.) A very considerable number of vegetables, particularly those belonging to the family Algae, yield it. The following are some instances: Fucus vesiculosis, F. serratus, and F. nodosus; (fig. 36, a, b, c.) Laminaria saccharina

Fig. 36.

a. Fucus vesiculosis.
b. F. nodosus.
c. F. serratus.
d. Laminaria digitata.

and L. digitata; (fig. 36 d) Halidrys siliquosa; Chorda Filum; Gelidium cartilagineum; Hatsyeris polyiodides; Phyllophora rubens; Rhodomenia palmata; Ulva Linza; Porphyra umbilicalis; Padina Pavonia; Gigartina Helminthocorton, and some of the marine Confera.

It has been found in several species of phænogamous plants, as Zos...
Iodine.  

By *I. marina*, and, more recently, in two growing in Mexico; namely, a species of *Agave* and a species of *Salsola*—(Journ. Pharm. tom. xxiii. p. 31.) 

**Preparation.**—Iodine is obtained from the *Fucoideae* (one of the divisions of the family *Algæ*). The plants of this tribe, by combustion, yield ash or cinder, commonly denominated kelp, which contains iodine. Auy states that French kelp is more productive than British; and dund, from experiments made at the Cape of Good Hope, concludes at the *Laminaria buccinalis* yields more than any European *Algæ*.

Kelp is a very heterogeneous substance. Its soluble parts are the iodides of sodium and potassium, carbonate of soda, sulphates of soda and potash, and the sulphuret and iodide of potassium or of sodium. These must be added a small quantity of alkaline bromide. The quantity of iodide, however, is very small in comparison with some of the other salts, and, therefore, the first object in the manufacture of iodine is to separate as much of these as possible. By repeated crystallizations readily attain this, since the iodide being very soluble is left in the other liquor, along with the sulphuret and a portion of the other salts. This liquor is introduced into a stoneware still, sulphuric acid and the oxides of the manganese are added, and heat applied. Iodine distills over, and after being washed with water, is dried between folds of bibulous paper.

In this process two equivalents, or 80 parts of sulphuric acid, react on one equivalent, or 44 parts of monoxide of the manganese, and on one equivalent, or 166 parts of iodide of potassium, and yield one equivalent, or 126 parts of iodine, one equivalent, or 88 parts of sulphate of potash, and one equivalent, or 76 parts of the sulphate of the protioxide of the manganese.

**Ingredients used.**

<table>
<thead>
<tr>
<th>Iodide Potash</th>
<th>166</th>
<th>1 eq. Iodine</th>
<th>126</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Potassium</td>
<td>40</td>
<td>1 eq. Potassium</td>
<td>48</td>
</tr>
<tr>
<td>1 eq. Oxygen</td>
<td>8</td>
<td>1 eq. Potassium</td>
<td>48</td>
</tr>
<tr>
<td>1 eq. Protosulphate Magnesium</td>
<td>36</td>
<td>1 eq. Potassium</td>
<td>48</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>80</td>
<td>1 eq. Sulphuric Acid</td>
<td>40</td>
</tr>
<tr>
<td>1 eq. Sulphuric Acid</td>
<td>40</td>
<td>1 eq. Potassium</td>
<td>48</td>
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</tbody>
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**Products.**

<table>
<thead>
<tr>
<th>Products</th>
<th>1 eq. Iodine</th>
<th>126</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphate Potash</td>
<td>8</td>
<td>1 eq. Sulphate Potash</td>
</tr>
<tr>
<td>Protosulphate Magnesium</td>
<td>76</td>
<td>1 eq. Protosulphate Magnesium</td>
</tr>
</tbody>
</table>

Bussy (Journ. Pharm. t. 23, p. 17) has proposed another mode of preparing iodine.

**Properties.**—Iodine is a crystallizable solid, its primary form being a mombic octahedron. It is usually met with in micaceous, soft, friable bodies, having a greyish black colour, a metallic lustre, an acid hot taste, and a disagreeable odour somewhat similar to that of chlorine. It fuses about 225° F., and at 347° is volatilized, though the vapour rises along that of water at 212°. Iodine vapour has a beautiful violet colour, and a great specific gravity; namely, 8.716, according to Dumas. Iodine purifies 7000 times its weight of water to dissolve, but alcohol and ether are much better solvents for it. Its atomic weight is about 126.

**Characteristics.**—In the free state iodine is distinguished from most other bodies by its forming an intense blue colour with starch. So delicate is this test, that Stromeyer says, water which does not contain more in one four-hundred and fifty thousandth of its weight of iodine, acquires a perceptibly blue tinge on the addition of starch. This blue colour is destroyed by heat, and, therefore, in testing for iodine the liquids played should be cold: an excess of alkali also destroys it by forming
two salts, an iodate and an iodide, but by supersaturating with acid the colour is restored.

The blue compound of iodine and starch is usually designated the iodide of starch, but Raspail, (Nouveau Système Chimie Organique) objects to the term, as grains of starch consist of two parts—an external envelope, within which is a soluble gummy substance. Now the iodine says Raspail, attaches itself to the envelope only, giving it a blue colour, just as it gives a yellow colour to other organic textures.

Iodine forms a blue compound with narceine (see Opium). The mineral acids (sulphuric, nitric, and hydrochloric) have the same effect on narceine.

When iodine is in combination with oxygen, starch will not reoxidise it. For example, if a little starch be added to a solution of iodide acid no change of colour is observed; but if some deoxidating substance be now employed (such as sulphurous acid or morphia) the blue colour immediately produced. The iodates give out oxygen when heated, and are converted into iodides. They deflagrate when thrown on red hot coals. The soluble iodates produce with a solution of the nitrate of silver, a white precipitate of iodate of silver soluble in ammonia. If the iodine be combined with a base (as with potassium, or sodium), chlorine or sulphuric or nitric acid must be employed to remove the latter; and then iodine being then set free, will react on the starch. This is the mode of proceeding to detect iodine in the urine of a patient; for the mere addition of starch will not suffice. Nitric or sulphuric acid or chloridne must be employed to remove the base with which the iodine is combined.

The soluble iodides produce, with a solution of nitrate of silver, a yellowish precipitate (iodide of silver) very slightly soluble only in ammonia. They precipitate the salts of lead yellow, and bichloride of mercury scarlet.

Purity.—We are told that iodine is much adulterated, but I doubt it. There are two properties which will, in most instances, determine its purity—namely, its solubility in alcohol, and, when heated, its conversion into violet vapour, leaving no residuum. Coal, plumbago, peroxide of manganese, sand, and charcoal (all of which, it is said, have been found in iodine), would be in this way readily distinguished. But Dr. O'Shaugnessy (Translation of Lugol's Essays, p. 210) states that he met with an specimen so artfully adulterated, that the foreign ingredients were at the same time soluble in alcohol and volatilizable by heat. A little imposition may be, and indeed is, practised by some dealers in iodine, by selling it in a moist state. An ounce, if very moist, may contain one drachm, or perhaps even a drachm and a half, of water. The easiest way of detecting this is by compression between folds of blotting paper.

Physiological Effects.—(a) On vegetables. Cantu states that seeds placed in pure sand and moistened with a solution of iodine, germinate more readily than seeds sown in the usual way. Vogel, however, asserts that iodine, so far from promoting, actually checks or stops germination (Decandolle, Physiolog. Végét. tom. 3\textsuperscript{me}. p. 1337).

(b) On animals generally.—Hitherto no examination has been made of the effects of iodine on the different classes of animals, for, with the exception of man, the only animals on which experiments have hitherto been made with it, are horses, dogs, and rabbits. On these it operates as an irritant and caustic poison, though not of a very energetic kind.
agendie threw a drachm of the tincture of iodine into the veins of a
g without causing any obvious effects (Formulaire). Dr. Cogswell has
pointed this experiment: the animal was slightly affected only (Experimental Essay on Iodine, p. 31, 1837). The last-mentioned writer found
at two drachms of the tincture caused death. But something must be
drived to the alcohol employed. Orfila (Toxicologie générale) applied
grains of solid iodine to a wound on the back of a dog: local inflam-
tion, but no other inconvenience, resulted. One or two drachms
ministered by the stomach caused vomiting, and when this was
vented by tying the esophagus, ulceration of the alimentary canal and
ath took place. Mr. Dick (Cogswell's Essay, p. 24) gave iodine, in
y large doses, to a horse for three weeks, but the only symptom which
could be referred to its influence was an unusual disregard for water.
verage daily allowance was two drachms, administered in quantities
ending from a drachm up to two ounces. Dr. Cogswell (op. cit. p. 60)
73 grains of iodine to a dog in nine days. Five days after the
osition of the iodine the dog was killed: the urine contained a highly
preciable quantity of iodine—and a trace, and but a trace, of iodine
was found in the blood, brain, and stomach.
(c) On mon.—The local action of iodine is that of an irritant. Applied
the skin it stains the cuticle orange-yellow, causes itching, redness,
ill desquamation. If the vapour of it, mixed with air, be inhaled, it
ites cough and heat in the air-passages, and promotes bronchial
ction. Swallowed in large doses it irritates the stomach, as will
presently mentioned.

The effects produced by the internal administration of iodine may be
sidered under the two heads of those arising from the use of small,—
all those produced by large doses.

1. In small, medicinal doses, we sometimes obtain the palliation, or even
removal of disease, without any perceptible alteration in the functions
the body. Thus, in a case of chronic mammary tumor which fell
nder my observation, iodine was taken daily for twelve months, without
ng rise to any perceptible functional change, except that the patient was
ually thin during this period. Sometimes it increases the appetite,
effect noticed both by Coindet (Biblioth. Univers. tom. 1d, Sciences ct
ls), and by Lugol (Essays, translated by Dr. O'Shangliness), from
ch circumstance it has been denominated a tonic. But the long-con-
ed use of it, in large doses, has, occasionally, brought on a slow or
onic kind of gastro-enteritis; an effect which I believe to be rare, and
met with when the remedy has been incautiously administered.

irritable subjects, and those disposed to dyspepsia, it occasions nausea,
ess, heat of stomach, and loss of appetite, especially after its use has
continued for some days: the bowels are oftentimes slightly relaxed,
least they are not usually constipated. More than one-third of the
ents treated by Lugol experienced a purgative effect; and when the
ctions were numerous, colics were pretty frequent (op. cit. p. 20).
adin (Dict. de Mat. Méd. t. 3me, p. 628), and Manson (Medical Re-
ces on Iodine), however, observed a constipating effect from the use
of iodine.
The action of iodine on the organs of secretion is, for the most part,
that of a stimulant; that is, the quantity of fluid secreted is usually
ased, though this effect is not constantly observed. Jörg (Material Zu
Lugol some but p. sink I sometimes a period seven p. tom. the thus take bronchocele, Leipsic, possesses yet London, other saliva, carefully have diminish does this. Manson's the in instances saw either whose are mentioned. Journal patients nasal effects, Dr. Manson (Medical Researches on the Effects of Iodine, London, 1825) does not believe that it possesses any emmenagogue powers, further that as a stimulant and tonic to the whole body. In one patient it occasioned so much sickness and disorder of stomach that the menstrual discharge was suppressed altogether. On several occasions iodine has caused salivation and soreness of mouth. In the cases noticed by Lugol the patients were males. In the Medical Gazette, vol. xvii. for 1836, two instances are mentioned, one by Mr. Winslow (p. 401), the other by Dr. Ely (p. 480). Other cases are referred to in Dr. Cogswell's work. This effect, however, I believe to be rare. De Carro (quoted by Bayle, op. cit. p. 50) denies that iodine causes salivation, but says it augments expectoration. Lastly, diaphoresis is sometimes promoted by iodine.

Two most remarkable effects which have been produced by iodine are absorption of the mammae and wasting of the testicles. Of the first of these (absorption of the mammae) three cases are reported in Hufeland's Journal (quoted by Bayle, op. cit. p. 162), one of which may be here mentioned. A healthy girl, twenty years of age, took the tincture of iodine during a period of six months, for a bronchocele, of which she became cured; but the breasts were observed to diminish in size, and notwithstanding she ceased to take the remedy, the wasting continued so that at the end of two years not a vestige of the mammae remained. Sometimes the breasts waste, though the bronchocele is undiminished. Reichenau (Christison, p. 180) relates the case of a female, aged twenty-six, whose breasts began to sink after she had employed iodine for five months, and within four weeks they almost wholly disappeared; yet her goitre remained unaffected. With regard to the other effect (wasting of the testicle) I suspect it to be very rare. I have seen iodine administered in some hundreds of cases, and never met with one in which atrophy either of the breast or testicle occurred. Magendie also says he never saw these effects, though they are said to be frequent in Switzerland.

A disordered condition of the cerebro-spinal system has in severe instances been caused by iodine. Thus slight headache and giddiness are not unfrequently brought on. Lugol tells us that, by the use of ioduretted baths, headache, drowsiness, intoxication, and even stupor are produced. Analogs symptoms were observed in some of Dr. Manson's cases; and in one there were convulsive movements.

A specific effect on the skin is sometimes produced by iodine, beside the diaphoresis before alluded to. Thus Dr. C. Vogel (Rust, Magazin Bd. 14, p. 156) gives an account of a lady, twenty-eight years of age, a yellow complexion, who from the internal employment of the tinctur
iodine, became suddenly brown, besides suffering with other morbid symptoms. After some days the skin had the appearance of having been soaked! Mr. Stedman (Medical Gaz. vol. xv. p. 447) says that in some scrofulous patients it improves the condition of the hair and scalp.

The rapid emaciation said to have been occasionally produced by iodine, as well as the beneficial influence of this substance in scrofulous cases, and the disappearance of viscerad and glandular enlargements under its use, have given rise to an opinion that iodine stimulates the phatic vessels and glands. Manson, however, thinks that it exerts no peculiar or specific influence over the absorbent system, which only participates in the general effects produced on the whole body. Androgol asserts, that instead of producing emaciation, it encourages growth and increase of size.

There can be no doubt that the continued use of iodine must produce some effect over the general nutrition of the body, and by altering the actions previously performed by the various organs and tissues, it may at one time cause the embonpoint described by Lugol, and at another may have the reverse effect: in one case it may promote activity of the absorbents, and occasion the removal of tumours of considerable size, in another check ulceration (a process which Mr. Key, the 19th vol. of the Medico-Chirurgical Transactions, denies to be one absorption, but considers to be one of degeneration or disorganization) cause the healing of ulcers.

Some ascribed to iodine an aphrodisiac operation. Kolley (Journ. Uplém. tom. 17, p. 307), a physician at Breslau, who took it for a nuchoele, says it had the reverse effect on him.

In some instances, the continued use of iodine has given rise to a morbid state of system, which has been designated iodism. The symptoms (termed by Dr. Coindet, iodie) are violent vomiting and purging, fever, great thirst, palpitation, rapid and extreme emaciation, aps, and small and frequent pulse, occasionally with dry cough, terminating in death. This condition, however, must be a rare occurrence, for it is now hardly ever met with, notwithstanding the frequency and the freedom with which iodine is employed. It has been noticed by Coindet (op. cit.), Gairdner (Essay on the of Iodine), Zink (Journ. Complem. xviii. p. 126), Jahn (quoted by Stiston, p. 181), and others. The daily experience of almost every titioner proves that the dangers resulting from the use of iodine have, to say the least of them, much exaggerated, and we can hardly expect that many symptoms which have been ascribed to the injurious action of this remedy ought to have been referred to other causes; personally, perhaps, they depended on gastro-enteritis. In some cases, remarkable activity of iodine may have arisen from some idiosyncracy be part of the patient. Dr. Coindet attributes the iodie symptoms the saturation of the system with iodine—an explanation, to a certain extent, borne out by the results of an experiment made by Dr. Cogswell, which I have before mentioned: I allude now to the detection of iodine in the tissues of an animal five days after he had ceased taking the substance.

In very large doses iodine has acted as an irritant poison. In a fatal case recorded by Zink (Journ. Compl. tom. xviii.) the symptoms were heat, burning, thirst, palpitations, very frequent pulse, violent
priapism, copious diarrhoea, excessive thirst, trembling, emaciation, and occasional syncope. The patient died after six weeks' illness. On another occasion this physician had the opportunity of examining the body after death. In some parts the bowels were highly inflamed, others they exhibited an approach to sphaecelation. The liver was very large, and of a pale rose colour.

Such cases, however, are very rare. In many which might be referred to, enormous quantities of iodine had been taken with very slight effect, or perhaps with no marks of gastric irritation. Thus Dr. Kennedy of Glasgow (quoted in Dr. Cogswell's Essay), exhibited within eight days, 953 grains of iodine in the form of tincture: the daily dose was first two grains, but ultimately amounted to 18 grains. The health of the girl appeared to be unaffected by it. It should here be mentioned that the presence of bread, potatoes, sago, arrow-root, tapioca, or other amylaceous matters, in the stomach, will much diminish the local action of iodine, by forming an iodide of starch, which, as will hereafter be mentioned, is a very mild preparation.

Modus Operandi. — That iodine becomes absorbed, when employed either externally or internally, we have indisputable evidence, by detection not only in the blood but in the secretions. Cantu (Journ. Chimie Méd. tom. ii. p. 291) has discovered it in the urine, sweat, saliva, milk, and blood. In all cases it is found in the state of iodide, hydriodate; from which circumstance he concludes that its influence on the body is chemical, and consists in the abstraction of hydrogen. Berscheidt (Journ. de Chim. Méd. tom. iv. p. 383) examined the serum of the blood of a patient who had employed for some time iodine ointment, but he could not detect any trace of iodine. In the crassamentum, however, he obtained evidence of its existence, by the blue tincture communicative to starch.

Uses.—(a.) In bronchocele. Of all remedies yet proposed for bronchocele, this has been by far the most successful. Indeed, judging from the numerous cases cured by it, and which have been published, we should almost infer it was a sovereign remedy. However, it is to be recollected that of those who have written on the use of iodine in the complaint, some only have published a numerical list of their successful and unsuccessful cases. Bayle (Bibliothèque de Thérapeutique, tom. 1st, p. 394) has given a summary of those published by Coster, Irnenger, Baup, and Manson, from which it appears that of 364 cases treated by iodine, 274 were cured. Dr. Copland (Dict. of Pract. Med.) observes that of several cases of the disease which have come before him since the introduction of this remedy into practice, "there has not been one which has not either been cured or remarkably relieved by it." Much regret, however, that my own experience does not accord with the statement. I have several times seen iodine, given in conjunction with iodide of potassium, fail in curing bronchocele; and I know others who experience has been similar. Dr. Bardsley (Hospital Facts and Observations, p. 121) cured only nine, and relieved six, out of thirty cases, with iodide of potassium. To what circumstance, then, ought we to attribute this variable result? Dr. Copland thinks that where it fails it has been given "in too large and irritating doses, or in an improper form; and without due attention having been paid to certain morbid and constitutional relations of the disease during the treatment."
But, in two or three of the instances before mentioned, I believe the
lure did not arise from any of the circumstances alluded to by Dr. Cop-
ul, and I am disposed to refer it to some peculiar condition of the
nor, or of the constitution. When we consider that the terms bron-
chele, goitre, and Derbyshire neck, are applied to very different con-
tions of the thyroid gland, and that the causes which produce them
are involved in great obscurity, and may, therefore, be, and indeed
probably are, as diversified as the conditions they give rise to, we can
only imagine that while iodine is serviceable in some, it may be useless
and even injurious in others. Sometimes the bronchocele consists in
pertonrophy of the substance of the thyroid gland,—that is, this organ is
larged, but has a healthy structure. In others, the tumefaction of the
and took place suddenly, and may even disappear as suddenly, from
which it has been inferred that the enlargement depends on an accumu-
lition of blood in the vessels, and an effusion of serum into its tissue.
Indet mentions a goitre which was developed excessively during the
third pregnancy of a young female: twelve hours after her accouchement
had entirely disappeared. The same author also relates the circumstance
of a regiment composed of young recruits, who were almost every man
packed with considerable enlargement of the thyroid gland, shortly after
their arrival at Geneva, where they all drank water out of the same pump.
Their quarters being changed the gland soon regained its natural size
in every instance. A third class of bronchoceles consists in an enlarge-
ment of the thyroid gland from the development of certain fluid or solid
stances in its interior, and which may be contained in cells, or be
filtrated through its substance. These accidental productions may be
bulous, honey-like, gelatinous, fibrous, cartilaginous, or osseous. Lastly,
times the enlarged gland has acquired a scirrhou's condition. Now it
impossible that all these different conditions can be cured with equal
facility by iodine; those having solid deposits are, of course, most difficult
t get rid of.
Kolley, the physician before alluded to, who was himself cured of a
large goitre of ten years' standing, says, that for iodine to be useful, the
unchocele should not be of too long standing, nor painful to the touch;
swelling confined to the thyroid gland, and not of a scirrhou's or car-
amomatous nature, nor containing any stony or other analogous concre-
escs; and that the general health be not disordered by any febrile or
nalmatory symptoms, or any gastric, hepatic, or intestinal irritation.
The swelling be tender to the touch, and have other marks of inflam-
ion, let the usual local antiphlogistic measures precede the employ-
ant of iodine. When this agent is employed we may administer it both
ormally and internally. The most effectual method of employing
the externally is that called endermic, already described; namely, to
ly an ioduretted ointment (usually containing iodide of potassium) to
egis vera, the epidermis being previously removed by a blister. But
epidermic, or iatroleptic method, is more usually followed—that is,
ioduretted ointment is rubbed into the affected part, without the
ermis being previously removed. On the agency of galvanism in
oting the passage of iodine into the system, I have already made
observations (see pp. 55-6).
ith respect to the internal use of this substance, some think that the
cess depends on the use of small doses largely diluted,—while others
consider that as large a quantity of the remedy should be administered to the stomach and general system can bear.

(b.) *Serofula* is another disease for which iodine has been extensively used. Dr. Coindet was, I believe, the first to direct public attention to this remedy in the disease in question. Subsequently, Baup, Gimelli, Kolley, Sablairoles, Benaben, Callaway, and others, published cases illustrative of its beneficial effects.—(See Bayle's *Bibliothèque de Thérapy* tom. i.) Dr. Manson *op. cit.* deserves the credit of having first tried iodine on an extensive scale. He treated upwards of eighty cases of scrofula and scrofulous ophthalmia by the internal exhibition of iodine, sometimes combined with its external employment; and in a large proportion of cases, where the use of the medicine was persevered in, the disease was either cured or ameliorated, the general health being also improved. Three memoirs on the effects of iodine in scrofula have been subsequently published by Lugol, physician to the Hospital St. Louis, serving to confirm the opinions already entertained of its efficacy. From the first memoir it appears, that in seventeen months—namely, from August, 1827, to December, 1828—109 scrofulous patients were treated by iodine only, and that of these 36 were completely cured, and 30 relieved; in 4 cases the treatment was ineffectual, and 39 cases were under treatment at the time of the report made by Serres, Magendie, and Dumeril, to the Académie Royale des Sciences. In his illustrative cases we find glandular swellings, scrofulous ophthalmia, abscesses, ulcers, and diseases of the bones, were beneficially treated by it. Lugol employs iodine internally and externally: for internal administration, he prefers iodine dissolved in water by means of iodide of potassium, given either in the form of drops, or largely diluted, under the form of what he calls *ioduretted minera water*, presently to be described. His external treatment is of two kinds, one for the purpose of obtaining local effects only, the other for promoting constitutional or general effects. His local external treatment consists in employing ointments or solutions of iodine: the ointments are made either with iodine and iodide of potassium, or with the protiodide of mercury; the solutions are of iodine and iodide of potassium in water and according to their strength are denominated caustic, rubefacient, or stimulant: the rubefacient solution is employed in making cataplasm and local baths. His external general treatment consists in the employment of *ioduretted baths*. Of these different preparations more will be said hereafter.

The successful results obtained by Lugol in the treatment of this disease cannot, I think, in many instances, be referred to iodine solely. Many of the patients were kept several months (some as much as a year) under treatment in the hospital, where every attention was paid to the improvement of their general health by warm clothing, good diet, the use of vapour and sulphurous baths, &c.; means which of themselves are sufficient to ameliorate, if not cure, many of the scrofulous conditions before alluded to. Whether it be to the absence of these supplementary means of diet and regimen, or to some other cause, I know not, but most practitioners will, I think, admit that they cannot obtain by the use of iodine the same successful results which Lugol is said to have met with, though in a large number of cases this agent has been found a most useful remedy.

(c.) Iodine has been eminently successful when employed in chronic...
diseases of various organs, especially those accompanied with induration and enlargement. By some inexplicable influence, it sometimes not only arrests a stop to the further progress of disease, but apparently restores the art to its normal state; hence it is placed by some pharmacologists (as Vogt and Sundelin) among the resolventia. It is usually given with the view of exciting the action of the absorbents, but its influence is not limited to this set of vessels: it exercises a controlling and modifying influence over the blood-vessels of the affected part, and is in the true sense of the word an alternative.

In chronic inflammation, induration, and enlargement of the liver, after antiphlogistie measures have been adopted, the two most important and probable means of relief are iodine and mercury, which may be used either separately or conjointly. If the disease admit of a cure these are the agents most likely to effect it. Iodine, indeed, has been supposed to possess some specific power of influencing the liver, not only from its efficacy in alleviating or curing certain diseases of this organ, but also from the effects of an over dose. In one case pain and induration of the liver were brought on;— and in another, which terminated fatally, this organ was found to be enlarged, and of a pale rose colour.—(Christison, Treatise on Poisons, pp. 180-1.)

Several cases of enlarged spleens relieved or cured by iodine have been published.

In chronic diseases of the uterus, accompanied with induration and enlargement, iodine has been most successfully employed. In 1828 a remarkable instance was published by Dr. Thetford (Trans. of the King and Queen's College of Phys. Ireland, vol. v). The uterus was of osseous hardness, and of so considerable a size as nearly to fill the whole of the pelvis: yet in six weeks the disease had given way to the use of iodine, and the catamenia were restored. In the Guy's Hospital Reports, No. I. 1836, is an account by Dr. Ashwell of seven cases of "hard tumours" of the uterus successfully treated by the use of iodine, in conjunction with occasional depletion and regulated and mild diet. Besides the internal use of iodine, this substance was employed in the form of ointment (composed of iodine gr. xv. iodide potassium Siij. spermactei oint. 5iss), of which portion (about the size of a nutmeg) was introduced into the vagina and rubbed into the affected cervix for ten or twelve minutes every night. It may be applied by the finger, or by a camel-hair pencil, or sponge mounted on a slender piece of cane. The average time in which resolution of the induration is accomplished varies, according to Dr. Ashwell, from eight to sixteen weeks. "In hard tumors of the walls or cavity of the uterus, resolution, or disappearance, is scarcely to be expected;" but hard tumors of the cervix, and indurated puckerings of the edges of the conditions which most frequently terminate in ulceration) may be elided down and cured by the iodine."—(pp. 152-3.)

In ovarian tumors iodine has been found serviceable. In the chronic amnry tumor, described by Sir A. Cooper, I have seen it give great relief—alleviating pain and keeping the disease in check. In indurated enlargements of the parotid, prostate, and lymphatic glands, several successful cases of its use have been published.

(d.) As an emmenagogue iodine has been recommended by Coindet, Terra, Sablairoles, Magendie, and others. The last-mentioned writer
tells us that on one occasion he gave it to a young lady, whose propriety of conduct he had no reason to doubt, and that she miscarried after using it for three weeks. I have known it given for a bronchocele during pregnancy without having the least obvious influence over the uterus.

(e.) In *gonorrhea* and *leucorrhrea* it has been employed with success after the inflammatory symptoms have subsided.

(f.) Inhilation of iodine vapour has been used in phthisis and chronic bronchitis. In the first of these diseases it has been recommended by Berton, Sir James Murray, and Sir Charles Scudamore. I have repeatedly tried it in this as well as in other chronic pulmonary complaints but never with the least benefit. The apparatus for inhaling it has been already described (see p. 51.) The liquid employed is a solution of ioduretted iodide of potassium, to which Sir C. Scudamore adds the tincture of conium.—(Med. Gaz. vol. viii. p. 157.)

(g.) Chronic diseases of the nervous system, such as paralysis and chorea, have been successfully treated by iodine, by Dr. Manson.

(h.) In some forms of the venereal disease, iodine has been found a most serviceable remedy. Thus, Roehond (quoted by Bayle, *op. cit.*) employed it, after the usual antiphlogistic measures, to remove buboes. De Sally cured chronic venereal affections of the testicles with it. Mr. Maye (Med. Gaz. vol xi. p. 249), has pointed out its efficacy in certain disorders which are the consequences of syphilis, such as emaciation of the frame, with ulcers of the skin; ulcerated throat; and inflammation of the bones or periostea,—occurring in patients to whom mercury has been given.

(i.) In checking or controlling the ulcerative process, iodine is, according to Mr. Key (Medico-Chirurg. Trans. vol. 19), one of the most powerful remedies we possess. "The most active phagedenie ulcers, that threaten the destruction of parts, are often found to yield in a surprising manner to the influence of this medicine, and to put on a healthy granulating appearance."

(k.) Besides the diseases already mentioned there are many others in which iodine has been used with considerable advantage: for example—chronic skin diseases, as lepra, psoriasis, &c. (Cogswell, *Essay*, p. 81):—dropsies (ibid); in old non-united fractures, to promote the deposition of ossifie matter (Med. Gaz. vol. vi. p. 512, 1830); in chronic rheumatism; but in this disease iodide of potassium is more frequently employed. As an antidote in poisoning by strychnia, brucia, and veratrum, iodine has been recommended by M. Donne (Journ. de Chim. Méd. tom. v. p. 494), because the compound formed by the union of these alkalies with iodine is less active than the alkalies themselves; as an injection for the cure of hydrocele, Velpean (Med. Gaz. vol. xx. p. 90), has employed a mixture of the tincture of iodine with water, in the proportion of from one to two drachms of the tincture to an ounce of water: of this mixture from one to four ounces are to be injected and immediately withdrawn; lastly, to check mercurial salivation iodine has been successfully used.—(Med. Gaz. vol. xiii. p. 32, and vol. xx. p. 144.)

Administration.—Iodine is rarely used alone, but generally in combination with the iodide of potassium: formulas for the conjoint exhibition of these I shall give when describing the iodide: at present I shall confine myself to those preparations into which iodine alone enters.
Before noticing these, however, it may not be amiss to mention that the view of preventing gastric irritation, we should avoid giving line on an empty stomach. If administered immediately after a meal, the topical action of this substance is considerably diminished. This is especially the case if potatoes, bread-pudding, sago, tapioca, or other oily substances, have been taken, since an iodide of starch (which possesses very slight local influence) is immediately formed in the stomach.

(a.) In substance, iodine has been given in the form of pills, in doses half a grain, gradually increased. But this mode of exhibition is now rarely resorted to.

(b.) Tincture of iodine.—This is a simple solution of iodine in rectified spirit, and may be made of various strengths. In the Dublin Pharmacopoeia the proportions are two scruples of iodine to one ounce (by weight) of spirit. It is, however, an objectionable preparation: for, in the first place, by keeping, part of the iodine is deposited in a crystalline form, so that the strength is apt to vary; secondly, it undergoes decomposition, especially when exposed to solar light; the iodine abstracts hydrogen from the spirit, and forms hydriodic acid, which, acting on some spirit, gives a little hydriodic ether. These are not the only objections: when added to water, the iodine is deposited in a solid state, and may thus choke the stomach. It is used both externally and internally: externally it may be mixed with the soap liniment, and internally it is exhibited in doses of from five or six drops to half a drachm. Each drachm contains five grains of iodine. The best mode of exhibiting it, to cover the flavour, is in sherry wine. Where this is inadmissible, sugared water may be employed.

c.) Combined with starch, iodine has been given in enormous quantities. Dr. Buchanan (Med. Gaz. vol. xvi. p. 515.) His formula for making the iodide of starch is the following:—"Rub 24 grs. of iodine with a little water, and gradually add one ounce of finely-powdered starch: dry a gentle heat, and preserve the powder in a well-stoppered vessel." Persons not labouring under any dyspeptic ailment or constitutional opacity of habit, Dr. Buchanan commences with half an ounce for a case, and increases this to an ounce three times a day,—equivalent to 72 grains daily. It frequently caused costiveness, attended with griping of the bowels and pale-coloured evacuation. In some cases, but rarely, it produced purging. Though starch diminishes or nearly destroys the irritant properties of iodine the prudent practitioner will commence with small doses, (3 ss.) of the iodide, and carefully watch the effect of gradually and cautiously increased doses. I have found the colour of the preparation objected to by patients.

d.) Combined with hydrogen, forming hydriodic acid, Dr. Buchanan (cit.) has given iodine in very large quantities. His formula for making this acid is the following:—"Dissolve 264 grs. of tartaric acid in 1½ ounces of distilled water, and to this add a solution of 330 grs. of iodide potassium also dissolved in 1½ ounces of distilled water. When the artefact of potash has subsided, strain, and, to the strained liquor, add sufficient water to make fifty drachms (3½.) of solution." Of this solution Dr. Buchanan has given as much as an ounce three times a day, two drachms of iodine daily, and he regards half an ounce as the
ordinary dose. But I would advise it to be given at first in very much smaller quantity (ss.), and to be gradually increased.

(e) Ointment of iodine.—This is composed, according to the Dublin Pharmacopoeia, of a seruple of iodine to an ounce of lard. If this be irritating, the quantity of lard must be increased. The colour of the compound is brown, but, by keeping, it becomes paler; and hence should always be made when wanted. It is employed as a local application to serofulous tumors, bronchocele, &c.

Antidotes.—In the event of poisoning by iodine, or its tincture, the first object is to evacuate the poison from the stomach. For this purpose assist the vomitings by the copious use of tepid demulcent liquids—especially by those containing amylaceous matter; as starch, wheat-flour, sago, or arrow-root, which should be boiled in water, and exhibited freely. The efficacy of these agents depends on the iodide of starch which they form, possessing very little local action. In their absence other demulcents, such as milk, eggs beat up with water, or even tepid water merely, may be given to promote vomiting. Magnesia is also recommended. Opiates have been found useful. Of course the gastro-enteritis must be combated by the usual means.

Order IV. Bromine.

Brominium.—Bro'mine.

History and Etymology.—This substance was discovered by M. Balard, of Montpelier, in 1826. He at first termed it muride (from muria, brine), in allusion to the substance from whence he procured it, but, at the suggestion of Gay-Lussac, he altered this name to that of brome, or bromine, (from βρωμος, a stench or fetor,) on account of its unpleasant odour.

Natural History.—It is found in both kingdoms of nature, but never in the free state.

(a.) In the inorganized kingdom.—Hollander detected it in an ore of zinc, and Coehler recognised it in Silesian cadmium (Gmelin, Handbuch der Chemie.) It exists in sea water and many mineral waters, in combination with either magnesium or sodium, or sometimes with both. Thus it has been found in the waters of the Mediterranean, the Baltic, the North Sea, the Frith of Forth, the Dead Sea, many of the brine-springs of Europe and America (as those of Middleton, Nantwich, Ashby-de-la-Zouch, and Shirleywich, in England), and in many other mineral springs of Europe and America (as the Pittville spring at Cheltenham, the water of Llandridod and of Bonnington.) It has been justly observed by Dr. Daubeny (Phil. Trans. 1830), that the detection of bromine in brine-springs is a fact interesting in a geological point of view, as tending to identify the product of the ancient seas, in their most minute particulars, with those of the present ocean.

(b.) In the organized kingdom.—Bromine has been found in the sea-plants of the Mediterranean, and in the mother-waters of Kelp. It has likewise been detected in marine animals, and in the sea-sponge (Spongia officinalis), in the stony concretion found in this animal, and in the ashes of the Janthina violacea, one of the gasteropodous mollusca.

Preparation.—Bromine is usually procured from bittern (the mother
quor of sea-water, from which the chloride of sodium has been separated by crystallization). A current of chlorine gas is passed through its liquid in order to decompose the bromide of magnesium, and thereby form chloride of magnesium and set free the bromine, as shown by this diagram:

**INGREDIENTS USED.**

<table>
<thead>
<tr>
<th>eq. Bromide Magn.</th>
<th>1 eq. Bromine 78</th>
</tr>
</thead>
<tbody>
<tr>
<td>sium 905</td>
<td>1 eq. Magn. 12</td>
</tr>
<tr>
<td>sq. Chlorine 36</td>
<td>1 eq. Chloride Magn. 48</td>
</tr>
</tbody>
</table>

The liquid through which the bromine is diffused is then to be strongly gitated with ether, by which an ethereal solution of this substance is stained, which floats on the water. To the decanted ethereal solution add caustic potash: six equivalents, or 468 parts of bromine, react on six equivalents or 288 parts of potash, and produce five equivalents or 600 parts of bromide of potassium, and one equivalent or 168 parts of borate of potash, as shown by the following diagram:

**INGREDIENTS USED.**

<table>
<thead>
<tr>
<th>eq. Bromine</th>
<th>. . . 390</th>
</tr>
</thead>
<tbody>
<tr>
<td>eq. Bromine</td>
<td>. . . 78</td>
</tr>
<tr>
<td>eq. Potash 240</td>
<td>5 eq. Pot. 200</td>
</tr>
<tr>
<td>eq. Ox. 40</td>
<td>5 eq. Ox. 40</td>
</tr>
<tr>
<td>eq. Potash 48</td>
<td>1 eq. Bromic acid 118</td>
</tr>
<tr>
<td>eq. Potash 48</td>
<td>1 eq. Brom. Pot. 166</td>
</tr>
</tbody>
</table>

In order to convert the bromate of potash into bromide of potassium the mass is exposed to a dull red heat, by which six equivalents or 48 parts of oxygen are evolved. The bromide of potassium is then dissolved with sulphuric acid and binoxide of manganese, and the disengaged bromine condensed in water. One equivalent or 118 parts of the bromide react on one equivalent or 44 parts of the binoxide of manganese, and on two equivalents or 80 parts of sulphuric acid; and by this action one equivalent or 78 parts of bromine, one equivalent or 88 parts of sulphate of potash, and one equivalent or 76 parts of the sulphate of the protoxide of manganese, are produced.

**INGREDIENTS USED.**

<table>
<thead>
<tr>
<th>eq. Brom. Pot. 118</th>
<th>1 eq. Brom. 78</th>
</tr>
</thead>
<tbody>
<tr>
<td>eq. Binox. Mang. 44</td>
<td>1 eq. Potash 48</td>
</tr>
<tr>
<td>Sulphuric Acid 40</td>
<td>1 eq. Potash Mang. 76</td>
</tr>
<tr>
<td>Sulphuric Acid 40</td>
<td>1 eq. Protox. Mang. 36</td>
</tr>
</tbody>
</table>

**PRODUCTS.**

<table>
<thead>
<tr>
<th>1 eq. Bromine . . . 78</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 eq. Brom. Pot. 590</td>
</tr>
<tr>
<td>1 eq. Bromic acid 118</td>
</tr>
<tr>
<td>1 eq. Brom. Pot. 166</td>
</tr>
<tr>
<td>1 eq. Sulph. Potash 88</td>
</tr>
<tr>
<td>1 eq. Protox. Mang. 76</td>
</tr>
</tbody>
</table>

**PROPERTIES.**—At ordinary temperatures bromine is a dark-coloured, very volatile liquid, which, seen by reflected light, appears blackish red; at viewed in thin layers, by transmitted light, is hyacinth red. Its odour strong and unpleasing, its taste acrid. Its sp. gr. is about 3; water ing 1. When exposed to a cold of —4° F. it is a yellowish brown, little crystalline solid. At ordinary temperatures liquid bromine olves ruddy vapours, so that a few drops put into a small vessel immediately fills it with the vapour of bromine. At 116½ F. bromine boils. The vapour is not combustible: a lighted taper plunged into it is immediately extinguished, but before the flame goes out it becomes red at the top and green at the lower part. Antimony or arsenic takes fire then dropped into liquid bromine: when potassium or phosphorus is dropped in, a violent explosion takes place. Bromine is a nonconductor of electricity: it is a bleaching agent: it dissolves very slightly only in
water, more so in alcohol, and much more so in sulphuric ether. It communicates a fine orange colour to starch.

**Characteristics.**—Liquid bromine is recognised by its colour, odour, volatility, and the colour of its vapour. To these characters must be added its powerful action on antimony, arsenic, and potassium, before mentioned, its dissolving in ether, forming a hyacinth red liquid, and the orange colour which it communicates to starch. It causes a yellowish white precipitate with a solution of the nitrate of silver. The only substances which resemble in their external appearance liquid bromine, are the terchloride of chromium and the chloride of iodine.

The soluble bromides cause white precipitates with the nitrate of silver, acetate of lead, and protonitrate of mercury. The precipitates are bromides of the respective metals. Bromide of silver is yellowish white, clotty, insoluble in boiling nitric acid, and in a weak solution of ammonia (by which it is distinguished from chloride of silver), but dissolves in a concentrated solution of this alkali. Heated with sulphuric acid it evolves vapours of bromine. If a few drops of a solution of chlorine be added to a solution of a bromide, and then a little sulphuric ether, we obtain an ethereal solution of bromine of a hyacinth red colour, which floats on the water.

The bromates when heated evolve oxygen, and become bromides. The bromates cause white precipitates with the nitrate of silver, the proto-salts of mercury, and with strong solutions of the acetate of lead. Bromate of silver is not soluble in nitric acid, but dissolves readily in solution of ammonia. If a few drops of hydrochloric acid be added to a bromate, and then some ether, a yellow or red ethereal solution of bromine is obtained.

**Physiological effects.**—(a.) *On vegetables.*—I am unacquainted with any experiments made with bromine on plants.

(b.) *On animals generally.*—The action of bromine on animals has been examined by Franz, (quoted by Wibmer, *Die Wirkung d. Arzneim.* 1er. Bd. p. 433; also in *Journ. Chim. Méd. t. v. p. 540;) by Barthez, by Butske, and by Dieffenbach (Christison, *on Poisons.* p. 187.) The animals experimented on were leeches, fishes, birds, horses, rabbits, and dogs. But notwithstanding the numerous experiments which have been performed, nothing satisfactory has been made out with respect to its mode of operation, beyond the fact of its being a local irritant and caustic, and, therefore, when swallowed, giving rise to gastro-enteritis. Injected into the jugular vein it coagulates the blood, and causes immediate death, preceded by tetanic convulsions. No positive inferences can be drawn as to the specific influence of bromine on any organs of the body. Some of the symptoms (such as dilated pupil, insensibility, and convulsions) would seem to indicate a specific affection on the brain. Franz frequently observed inflammation of the liver.

(c.) *On man.*—Bromine stains the cuticle yellowish brown, and by continued application acts as an irritant. Its vapour is very irritating when inhaled, or applied to the mucous lining of the nose or to the conjunctiva. Franz, by breathing the vapour, had violent cough, and a feeling of suffocation followed by headache. Butske swallowed a drop and a half of bromine in half an ounce of water, and experienced heat in the mouth, oesophagus, and stomach, followed by colicky pains.
two drops occasioned nausea, hiccup, and increased secretion of mucus.

The constitutional effects resulting from the continued use of bromine are not been determined. They are probably analogous to those of iodine.

Hitherto no cases of poisoning with it in the human subject have been seen.

Uses.—It seems to possess the same therapeutic influence as iodine, and has been administered in bronchocele, in scrofula, in tumors, in menorrhœa, and against hypertrophy of the ventricles. It is usually regarded as possessing more activity than iodine.

Administration.—It may be administered dissolved in water. An aqueous solution, composed of one part by weight of bromine and forty parts of water, may be given in doses of five or six drops properly diluted and flavoured with syrup. This solution has also been used as an external agent in lotions.

The bromides of potassium, iron, and mercury, have been employed in medicine, and will be described hereafter. An ointment containing bromide of potassium and liquid bromine has been used, and will be noticed when speaking of the bromide.

Antidotes.—The treatment of cases of poisoning by bromine should be the same as for poisoning by iodine. Barthez has recommended magnesia as an antidote.

Order 5.—Hydrogen, and its Compounds with Oxygen and Chlorine.

Hydrogen.—Hydrogen.

History and Synonymes.—Cavendish may be considered as the real discoverer of hydrogen, though it must have been occasionally procured, and some of its properties known, previously. He termed it inflammable air. Lavoisier called it hydrogen (from ὑδρός, water, and γεννάω, I beget produce), because it is the radicle or base of water.

Natural History.—It is found in both kingdoms of nature, but always in combination.

(a) In the inorganized kingdom.—Next to oxygen, it may be regarded as the most important constituent of the terraqueous globe. It constitutes 11.1 per cent. by weight of water, presently to be noticed. It is an essential constituent of some minerals (as coal and sal ammoniac) in which it does not exist as an element of water. Lastly, it is evolved from juices or from fissures in the earth, in combination with carbon, sulphur, chlorine or nitrogen, under the forms of light carburetted hydrogen, sulphuretted hydrogen, hydrochloric acid, and ammonia.

(b) In the organized kingdom—Hydrogen is an essential constituent of all organized beings (animals and vegetables), either combined with oxygen, to form water, or otherwise. Certain fungi exhale both night and day hydrogen gas (Decandolle, Phys. Vég. tom. i. p. 459.)

Preparation.—Hydrogen is always procured by the decomposition of water, but this may be effected in three ways—by the action of electricity,
of heat and iron, or of sulphuric acid and a metal (zine or iron). The latter method only will require notice here.

Add some granulated zinc to a mixture of 1 part sulphuric acid and 5 e 6 parts of water by measure. One equivalent or 32 parts of zinc decomposes one equivalent or 9 parts of water, and unites with one equivalent or 8 part of the oxygen, forming one equivalent or 40 parts of the oxide of zinc while an equivalent or 1 part of hydrogen is evolved from the water. This equivalent of oxide of zinc combines with an equivalent or 40 part of sulphuric acid, and forms one equivalent or 80 parts of the sulphate of zinc.

**INGREDIENTS USED.**

<table>
<thead>
<tr>
<th>Prod.</th>
<th>Ingrd.</th>
<th>Grund ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Water</td>
<td>9</td>
<td>1 eq. Hydrogen 1</td>
</tr>
<tr>
<td>1 eq. Zinc</td>
<td>32</td>
<td>1 eq. Oxide Zinc 40</td>
</tr>
<tr>
<td>1 eq. Sulphuric Acid</td>
<td>40</td>
<td>1 eq. Sulphite. Zinc 8</td>
</tr>
</tbody>
</table>

It is remarkable that zinc alone does not decompose water, but sulphuric acid enables it to do so.

**Properties.**—Hydrogen is a colourless, tasteless, and, when pure odourless gas. Its sp. gr. is 0·0694,—so that it is 14.4 times lighter than atmospheric air. Its refractive power is very high. It is combustible, burning in atmospheric air or oxygen gas with a pale flame, and forming water. It is not a supporter of combustion. It is a constituent of some powerful acids, as the hydrochloric, and of a strong base, ammonia. Its atomic weight or equivalent is 1. Its atomic volume is also 1.

**Characteristics.**—It is recognised by its combusibility, the pale colour of its flame, its not supporting combustion, and by its yielding when exploded with half its volume of oxygen, water only.

**Physiological Effects.** (a.) On vegetables.—Plants which are deprived of green or foliaceous parts, or which possess them in small quantity only, cannot vegetate in hydrogen gas; thus seeds will not germinate in this gas; but vegetables which are abundantly provided with these parts vegetate for an indefinite time in hydrogen (Saussure, Recherches Chem. sur la Végét. pp. 195 and 209). Applied to the roots of plants in the form of gas, it is injurious (ibid. p. 105.), but an aqueous solution of it seems to be inert (Decandolle, Physiol. Végét. t. iii. p. 1360). It has been said that when plants are made to vegetate in the dark their etiolation is much diminished, if hydrogen gas be mixed with the air around them; and in proof of this Humboldt has mentioned several green plants found in the Freyberg mines (Thomson’s Syst. of Chemistry, 6th ed. p. 347-8.)

(b.) On animals generally.—Injected into the jugular vein of a dog hydrogen produces immediate death, probably from its mechanical effects in obstructing the circulation and respiration (Nysten, Recherches, p. 10.)

(c.) On man.—It may be breathed several times without any injurious effects. Scheele made twenty inspirations without inconvenience. Pilatre de Rozier frequently repeated the same experiment, and to shew that his lungs contained very little atmospheric air he applied his mouth to a tube, blew out the air, and fired it, so that he appeared to breathe flame. If much atmospheric air had been present detonation must have taken
HISTORY.

The ancients regarded water as an elementary substance, as a constituent of most other bodies. This opinion, apparently supported by numerous facts, was held until the middle of the last century, when the Hon. Mr. Cavendish proved that this liquid was a compound of oxygen and hydrogen. It is, however, only doing justice to Watt to say, that he had previously inferred this to be the composition of water, but was deterred from publishing his opinion in consequence of the opposition of Dr. Priestley's experiments being apparently opposed to it.

NATURAL HISTORY.—(a) In the inorganic kingdom. Water exists in the atmosphere; forms seas, lakes, and rivers; it is mechanically disseminated among rocks; and, lastly, it constitutes an essential part of some minerals.—In the atmosphere it is found in two states: as a vapour which makes about one-seventieth by volume, or one one-hundredth by weight, of the atmosphere; it is supposed to be the cause of the blue colour of the sky; and, in a vesicular form, it constitutes the clouds. Terrestrial water forms about three-fourths of the surface of the terrestrial globe. The average depth of the ocean is calculated at between one and three miles. Now, as the height of dry land above the surface of the sea is less than two miles, it is evident, that if the present dry land were distributed over the bottom of the ocean, the surface of the globe would present a mass of waters a mile in depth. On the supposition that the mean depth of the sea is not greater than the fourth part of a mile, the solid contents of the ocean would be about 32,058,939 cubic miles. H. G. J. Thomson, System of Chemistry, 6th ed. vol. iii. p. 195). The quantity of water disseminated through rocks must be, in the aggregate, very considerable, although it is impossible to form any correct estimate of it.
Water enters into the composition of many minerals, either as *water crystallization*, or combined as a *hydrate*.

(b.) *In the organized kingdom*, water is an essential constituent of vegetables and animals.

**Preparation.**—Absolutely pure water may be procured by combining its elements. For all practical purposes it is obtained sufficiently pure by the distillation of common water. But water which has been repeatedly distilled gives traces of acid and alkali when examined by the agency of galvanic electricity. Distilled water remains unchanged by the addition of any of the following substances:—solutions of the caustic alkalis, lime water, oxalic acid, the barytic salts, nitrate of silver, an solution of soap. If any turbidity, milkiness, or precipitate, be occasioned by any of the above, we may infer the existence of some impurity in the water. But the most delicate test of the purity of water is galvanism, as before mentioned. The purest natural water is snow and rain water; then follow river, spring, and well waters.

**Properties.**—Pure water has the following properties:—at ordinary temperatures it is a transparent liquid, usually described as being both odourless and colourless; but it is well known that the camel can see water at a considerable distance, so that to this animal it is odorous and as regards its colour, we know that all large masses of water have bluish-green colour, though this is usually ascribed to the presence of foreign matters. When submitted to a compressing force equal to 30,000 lbs. on the square inch, 14 volumes of this liquid are condensed into 13 volumes; so that it is elastic. A cubic inch of water, at 60°F weighs 255.5 grains; so that this fluid is about 815 times heavier than atmospheric air: but being the standard to which the gravities of solid and liquids are referred, its specific weight is usually said to be 1. At temperature of 32°, it crystallizes, and in so doing expands. The fundamental form of crystallized water (ice) is the rhombohedron. Water evaporates at all temperatures, but at 212° boils, and is converted into steam whose bulk is about 1700 times that of water, and whose sp. gr. is 0.62 (that of hydrogen being 1). Water unites with both acids and bases, but without destroying their acid or basic properties. Thus the crystallized vegetable acids, tartaric, citric, and oxalic, are atomic combination of water with acids. Potassa fusa and slacked lime may be instanced as compounds of water and basic substances:—these are called hydrate. It is a chemical constituent of some crystallized salts; for example, alum, sulphate of soda, and sulphate of magnesia. Here it exists as water of crystallization. It rapidly absorbs some gases—as fluoride of boron, ammonia, &c. It is neither combustible nor a supporter of combustion.

**Characteristics.**—In the liquid state it is recognized by being volatile, tasteless, odourless, neither acid nor alkaline, and not combustible nor a supporter of combustion: it is miscible with alcohol, but not with the fixed oils; if potassium be thrown on it in the open air, the metal takes fire. Lastly, water may be decomposed into oxygen and hydrogen by the galvanic agency. The most delicate test of aqueous vapour in any gas, is fluoride of boron (commonly called fluoboric acid gas), which produces white fumes with it.

**Composition.**—The composition of water is determined both by analysis and synthesis. If this liquid be submitted to the inful-
of a galvanic battery, it is decomposed into two gases—
mely, one volume of oxygen, and two volumes of hydrogen. These
gases, in the proportions just men-
tioned, may be made to recombine, and
form water; by heat, electricity, or spongy
platinum.

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<tbody>
<tr>
<td>Hydrogen</td>
<td>1</td>
<td>11:11</td>
<td>1</td>
<td>0:0694</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>88:9</td>
<td>0:5555</td>
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<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>100:00</td>
<td>0:6249</td>
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Physiological effects.—Water is a vital stimulus; that is, it is one
the external conditions essential for the manifestation of life. It con-
utes four-fifths of the weight of the tissues, and is the source of their
physical properties, extensibility and flexibility. Considered in a dietet-
al point of view, it serves at least three important purposes in the
mal economy: namely, it repairs the loss of the aqueous part of the
od, caused by the action of the secreting and exhalting organs;
ondly, it is a solvent of various alimentary substances, and, therefore,
ast the stomach in the act of digestion, though, if taken in very large
ities, it may have an opposite effect, by diluting the gastric juice;
ondly, it is probably a nutritive agent, that is, it assists in the formation
the solid parts of the body.

In a medicinal point of view, the physiological effects of water are
ch modified by its temperature.

21. Effects of tepid water.—Water moderately warm, and which
ther cools nor heats the body, acts locally as an emollient, softening
relaxing the various tissues to which it is applied. When swallowed
ays thirst, becomes absorbed, mixes with, and thereby attenuates, the
od, and promotes exhalation and secretion, especially of the watery
ls. Administered in large quantities it excites vomiting. The con-
ed excessive use of water has an enfeebling effect on the system, both
relaxing influence on the alimentary canal and by the excessive
ion which it gives rise to.

jected into the veins in moderate quantities, tepid water has no
rious effects; it quickens the pulse and respiration, and increases
ion and exhalation. Large quantities cause difficulty of breathing
an apoplectic condition. Thrown with force into the carotid artery
ills by its mechanical effect on the brain. I have already (p. 23)
e some observations on the action of water on the sanguineous
les out of the body.

22. Effects of ice, snow, and ice-cold water.—The temperature of these
sts is not higher than 32° F. When brought in contact with a living
, they produce two series of effects—the first of which may be deno-
ated direct, primary, or immediate; while the second may be termed
rect, secondary, or mediate, since they are developed by the vital
ons, after the cold agent has ceased to act.

Of the primary effects.—When ice is applied to the body, it
acts heat, causes pain, reduces the volume of the part, and diminishes
vital action; and, if applied for a sufficient period, occasions mortification—an effect which is hastened by the previously weakened condition of the part. If applied to a large surface of the body, and for a sufficient length of time, the processes of secretion, circulation, and respiration, are checked, and stupification, followed by death, ensues.

When taken internally, the sensation of cold which it produces is not so obvious as that occasioned by its external application and the effect is more temporary, from the greater heat of the internal parts, by which the ice is sooner melted, and the resulting liquid quickly raised to the temperature of the body. If, however, it be taken in large quantity, the effects are of the same general kind as those already described; namely, a sensation of cold in the epigastrium, some times attended with shivering; diminished frequency of pulse; temporary contraction of the alimentary canal; diminution of irritability, and secretion. Employed in small quantities, these effects are not at all perceived, or are only momentary; and the second stage, or that of reaction, almost immediately follows. Baglivi (quoted by Wibmen) found that the injection of four ounces of cold water into the jugular vein of a dog caused shivering of the whole body.

β. Secondary effects.—When the application of cold is temporary more especially if the subject be young and robust, reaction follows the removal of the cold agent. The vascular action of the part is increased, the pulse becomes full and more frequent, and the animal heat is restored to its proper degree, or is even increased beyond its natural standard. These effects, more or less modified, are observed both from the internal and external employment of ice. Thus, after the internal use of it, a feeling of warmth at the epigastrium soon succeeds that of cold, and this extends shortly over the whole body; the secretions of the alimentary canal, of the kidneys, and of the skin, are increased; and the circulation is accelerated. Sometimes these secondary effects are attended with those of a morbid character; thus, inflammation of the stomach has been brought on by the employment of ice.

γ. Effects of hot, but not scalding, water.—Hot, but not scalding water increases the temperature and volume of living parts, relaxes the tissues, and augments vital activity. Applied to the skin it causes rubefaction.

δ. Effects of boiling water and steam.—Both of these are local irritants, and, if sufficiently long applied, caustics, giving rise to extensive and deep eschars. Steam contains more specific heat than boiling water, but its conducting power is less than the latter.

Uses.—These may be subdivided into internal and external.—

1. Internal. (a) Of ice and ice-cold water.—Sometimes we administer ice internally, for the purpose of obtaining its primary effects: thus, in haemorrhage from the stomach we use it for the purpose of causing contraction of the vessels of the gastric surface, and thereby of checking or stopping sanguineous exhalation. So also in violent pulmonary, or bronchial, or nasal haemorrhage, ice-cold water, taken into the stomach, has been found beneficial. In most cases, however, we use it on account of its secondary effects. Thus, in relaxed and atonic conditions of the stomach—in dyspepsia and cardialgia, it is employed to check vomiting, and to allay spasmodic pain. In those forms of fever demen-
nated putrid, the internal use of small quantities of ice is sometimes highly serviceable.

(b) Of cold water. a. Taken into the stomach.—Cold water was employed as a drink in fevers in the time of Hipppocrates, who, as well as Ibnus, Galen, and other ancient writers, strongly recommended its use. Ibnus, in speaking of ardent fever, says, “Cum vero in summo incremento morbus est, utique non ante quartum diem, magna sit antecedente, gida aqua copiose praestanda est, ut bibat etiam ultra satietatem.”

Cold water constitutes the febrifugum magnum of Dr. Hancock. We are indebted to Dr. Currie for examining the circumstances under which exhibition is proper. According to him, it is inadmissible during the cold or sweating stage of fever, but may be employed with safety and advantage when the skin is dry and burning. In other words, the regulations for its administration are precisely the same as for the cold fusion presently to be noticed. When exhibited under proper circumstances it acts as a real refrigerant, reducing preternatural heat, lowering pulse, and disposing to sweating. I ought not, however, to omit noticing, that serious and even fatal consequences have resulted from the employment of large quantities of cold water by persons who have been ordered very warm by exercise and fatigue.

Besides fever, there are many other affections in which cold water is a useful remedy. For example, to facilitate recovery from an attack of epilepsy or hysteria, and also in fainting, a draught of cold water is sometimes beneficial. There are also various morbid states of the alimentary canal in which cold water may be administered with advantage; as, to diminish irritable conditions of the stomach, and allay vomiting and gastrodynia. Large quantities of cold water are sometimes caused the expulsion of intestinal worms (both Tania Ascaris vermicularis, or small thread-worms, commonly termed urides, and which are found in the large intestines of children, particularly in the rectum). Salt-water acts more efficaciously, as I shall after have occasion to notice.

b. Injected into the rectum.—Cold water is thrown into the rectum sometimes to check haemorrhage; to cause the expulsion of worms (the ill thread-worm); to allay pain; in poisoning by opium; in inflammation of the bowels; and in various other cases.

c. Injected into the vagina.—Dr. A. T. Thomson speaks very favourably of the effects of cold water when applied in uterine haemorrhages means of the stomach pump, and he says he has seen it used in several cases most successfully.

d. Tepid and warm water. a. Taken into the stomach.—Tepid and warm drinks are employed for various purposes; as, for promoting vomiting to dilute the contents of the stomach and to render them less acrid, in cases of irritant poisoning; but in poisons acting by absorption, emetics are objectionable, since they facilitate this process, and, therefore, ought not to be given unless vomiting be present, or the cach-pump be at hand. Warm aqueous drinks are administered with view of exciting diaphoresis, in gout, rheumatism, catarrh, &c., and to assist their operation the patient should be kept warm in bed, in order to promote the cutaneous circulation. Warm liquids are often used as emollients; as to allay irritable and troublesome cough, particularly when this appears to depend on irritation at the top of the larynx.
β. Injected into the rectum, warm water is sometimes employed to promote the haemorrhoidal flux, and thereby to relieve affections of distant organs; as an emollient, to diminish irritation either in the large intestine itself, or in some neighbouring organ, namely, the bladder, prostate gland, or uterus; to promote the catamenial discharge, &c. Clysters of tepid water are frequently employed to excite alvine evacuations. I have before (p. 53) expressed my opinion as to the impropriety of frequently introducing several pints of fluid into the rectum, since the gut, by dilatation, becomes less susceptible to the natural stimulus of the faeces.

γ. Injected into the vagina, warm water may be used to diminish irritation or pain in the womb,—to promote the lochial discharge, &c.

δ. Injected into the bladder, warm water is sometimes employed either to diminish irritation in this viscus, or to distend it previously the operation of lithotripsy.

e. Injected into the urethra, it has been used to allay irritation, or check discharges from the mucous membrane.

ζ. Injected into the veins, warm water was proposed by Magendie as a remedy for hydrophobia, but it has neither theory nor experience to recommend it. However, in a disease which has hitherto resisted a known means of cure, practitioners are glad to try any remedy that may be proposed, however improbable, or unlikely of success. I have already (p. 55) mentioned a case in which I tried warm water injections, but without much benefit. Vernière (Christison's Treatise on Poisons, p. 35) has proposed to distend the venous system with warm water, to check or stop absorption in poisoning; by those agents whose operation depends on their absorption; for example, opium. I am not acquainted with a case in which it has been tried on the human subject. Warm water sometimes a medium for the introduction of other more powerful agents into the circulating system; as, for example, tartar emetic.

d. Vapour.—The inhalation of aqueous vapour acts as a serviceable emollient in irritation or inflammation of the tonsils, or of the membranous lining of the larynx, trachea, or bronchial tubes. It may be employed by means of Mudge's inhaler, or by merely breathing over warm water. Various narcotic and emollient substances are frequently added to the water, without increasing its therapeutical power. In some pulmonary complaints, Dr. Paris states he has been long in the habit of recommending persons confined in artificially warmed apartments to evaporate a certain portion of water, whenever the external air has become excessively dry by the prevalence of the north-east winds which so frequently infest this island during the months of spring; and the most marked advantage has attended the practice.

II. EXTERNAL.—a. Ice and ice-cold water.—Ice is sometimes applied externally to check haemorrhage, more especially when bleeding vessel cannot be easily got at and tied. Thus, after operation about the rectum (more especially for piles and fistula) haemorrhage sometimes occurs to a most alarming extent; and in such cases principal reliance must be on cold. In two instances that have fallen under my own observation, I believe the lives of the patients were preserved by the introduction of ice within the rectum. In many other cases of haemorrhage, the external application of cold (either in the form of or ice-cold water) is exceedingly useful. Thus, applied to the chest
angerous pulmonary haemorrhage, to the abdomen in violent floodings, is oftentimes most beneficial. In some of these cases, especially in acute haemorrhage, more benefit is obtained by pouring cold water from height, than by the mere use of ice.

Pounded ice, tied up in a bladder, has been applied to hermial tumors, diminish their size and facilitate their reduction; but notwithstanding at the practice has the sanction and recommendation of Sir Astley Cooper, it is, I believe, rarely followed, not having been found successfull; and if too long continued, it may cause gangrene. In this, as well as in her cases where ice or snow cannot be procured, a freezing mixture may be substituted. For this purpose, five ounces of muriate of ammonia, five ounces of nitre, and a pint of water, are to be placed in a ladder, and applied to the part. Ice has also been applied in prolapsus of the rectum or vagina, when inflammation has come on which threatens perforation.

In inflammation of the brain, ice, pounded and placed in a bladder, may be applied to the head with a very beneficial effect. In fever also, where there is great cerebral excitement, with a hot dry skin, I have seen advantageously employed. In apoplexy, likewise, it might be useful. The retention of urine to which old persons are liable, ice-cold water applied to the hypogastrium is sometimes very effective, causing the evacuation of this secretion.

In the above-mentioned local uses of ice, we either apply it directly to the part, or inclose it in a bladder: the latter is to be preferred, since the patient is not wetted with the melted water, while the effect is less violent.

In the last place, I must notice the employment of ice or snow in the form of friction. Whenever it is used in this way, the ultimate object is the production of the secondary effects, or those which constitute the stage of reaction. Thus this practice has been resorted to in diminished sensibility of the skin, in the rheumatism or gout of old and enfeebled persons, in order to produce excitement of the skin; but its most common use is as an application to parts injured by cold. The affection thus induced is called pernio, or the chilblain; and the parts affected is said to be frost-bitten. The feet, hands, tip of the nose, and inner part of the ear, are the organs most frequently attacked. Now, with a view of preventing the mortification and other ill consequences arising from the application of cold, great care must be used to avoid sudden changes of temperature. The frost-bitten part, or the chilblain, could be rubbed with snow or pounded ice, or bathed in ice-cold water, very gradually raising the temperature of the applications until the part acquires its natural heat.

(b) Cold, cool, tepid, and hot water.—Water of various degrees of temperature is employed for baths, affusion, washing or sponging, the douche, &c for various local purposes.

a. Baths.—History.—The practice of bathing is of great antiquity, and, in fact, precedes the date of our earliest records. It was employed, sometimes for the purpose of cleanliness, sometimes for the preservation of health, and frequently as a means of sensual gratification. Ablutions were practised by the ancient Hebrews, as you will find mentioned in the Old Testament. Baths were used by the Egyptians, as well as by the

BATHS.
Hindoos, the Syrians, the Medes, the Persians, and other inhabitants of the East. The most ancient of the Greek writers also frequently mention them: thus Homer speaks of them in the Iliad and Odyssey. In the writings attributed to Hippocrates, you will find baths alluded to, and their effects noticed. Celsus describes the different parts of baths, and the mode of employing them; but the best description will be found in the works of Galen.

The following is a sketch of the baths of the Romans, copied from a painting found at the thermæ of Titus. (De Montfaucon, *L'Antiquité expliquée et représentée en figures*, tom. 3<sup>me</sup>, part 2<sup>de</sup>, p. 204).

Fig. 37.

![Ancient Baths.](image)

On the right is the *eleotherrion* (ἐλεοθέριον) where the oils and perfumes are kept in vases; next to this is the *frigidarium* (ἀφροθήριον) or dressing-room: the third is the *tepiderium*: the fourth is the sudatory (concatorata: sudatio) in which are seen the *laconicum* (so called from being first used in Laconia) a brazen furnace to heat the room, and persons sitting on the steps: the fifth is the balneum, with its huge basin (labrum) supplied by pipes communicating with three large bronze vases, called *milliaria*, from their capaciousness; the lower one contained hot, the upper one cold, and the middle one tepid water. The bathers returned back to the *frigidarium*, which sometimes contained a cold bath. The subterranean portion of the building, where the fires were placed for heating the baths, was called *hypocaustum*.

For further information on the ancient baths, consult "An Account of the Ancient Baths," by Thomas Glasse, M. D. 1752," or Dr. Parr's "Medical Dictionary." All the remarks made on baths by the Greeks, Latins, and Arabs, have been brought together in one volume,folio, under the following title:—"De Balneis omnia que extant apud Graecos, Latinos, et Arabos, 1553."

Effects and uses of baths.—The effects of baths depend, for the most part, on the temperature of the fluid employed, on its conducting power and, in part also, on its pressure. We may, therefore, conveniently arrange them thus:

(a.) Liquid baths.

1. The cold bath.
2. The cool bath.
3. The temperate bath.
4. The tepid bath.
5. The warm bath.
6. The hot bath.

(b.) Vapour baths.

Writers are not agreed on the precise temperature of the above baths but the order in which I have arranged them, according to their respective degrees of heat, is that which is generally admitted.

1. The Cold Bath.—The temperature of this ranges from 33° 1° to
about 60° F.; when it is below 50°, it is sometimes termed a very cold bath. The effects of immersion in the cold bath are analogous to those already described as being produced by the application of ice or snow to the body, and, therefore, may be conveniently subdivided into primary and secondary.

(a) Primary effects.—(The shock.)—The sudden abstraction of heat from the surface, and the pressure of the water, produce a powerful shock to the system: a sensation of cold, (speedily followed by a sensation of warmth) contraction of the cutaneous vessels, paleness of the skin, diminution of perspiration, and reduction of the volume of the body, are the immediate effects. Shivering, and, as the water rises to the chest, a kind of convulsive sobbing, are also experienced. Continued immersion renders the pulse small, and, ultimately, imperceptible—the respiration difficult and irregular; a feeling of inactivity succeeds—the joints become rigid and inflexible—pain in the head, drowsiness, and cramps, are experienced—the temperature of the body falls rapidly, and faintness, followed by death, comes on. Many of these symptoms are readily comprehended: the contracted state of the superficial vessels produced by the cold, together with the pressure of the water, causes the blood to accumulate in the internal vessels. The heart makes great efforts to get rid of this increased quantity of blood, and hence palpitations occur; but if the arteries remain contracted, the pulse continues small. The internal veins, therefore, being gorged with blood, the brain necessarily suffers:—hence the headache, the drowsiness, the cramps, and, in some cases, apoplexy. The difficult respiration depends on the accumulation of blood in the lungs. The contracted state of the superficial vessels accounts for the diminished perspiration; while the increased secretion of urine is referrible to the blood being driven towards the internal organs.

(b) Secondary effects.—(Re-action or glow.)—In general, the immersion being only temporary, re-action quickly takes place; a sensation of warmth soon returns; the cutaneous circulation is speedily re-established; a glow is felt; perspiration comes on; the pulse becomes full and frequent; and the body feels invigorated. In weakly and debilitated subjects, however, this stage of re-action may not occur, or at least may imperfectly effected; and usually, in such cases, the cold bath will be found to act injuriously.

The uses of the cold bath may be in part comprehended from the effects just detailed. It is employed with the view of obtaining one of the three following effects: the nervous impression or shock,—the refrigeration,—the re-action or glow. (Cyclopædia of Practical Medicine, art. bathing, by Dr. J. Forbes.) It is evident that it ought not to be applied unless there is a sufficient degree of tone and vigour in the system to cause a perfect state of re-action; and, therefore, in weak subjects, its use is to be prohibited. So also, in visceral inflammation, more specially peripneumonia, it is a dangerous remedy; since the determination of blood to the internal organs is increased by the cold, and it seems even within the range of probability that death might be the result. Apoplectic subjects, who are unaccustomed to cold bathing, had also, for similar reason, better avoid trying it. In some affections of the nervous system it has been found highly useful; for example, in tetanus and
insanity. So also, in any cases where we wish to increase the tone and vigour of the body, and where the before-mentioned objections do not exist, the cold bath may be used advantageously. It is a common opinion that immersion in cold water is dangerous when the body is heated by exercise, or other exertion; and hence it is customary with bathers to wait until they become cool. Dr. Currie has strongly combated both the opinion and the practice: the first, he says, is erroneous, the second injurious.

(2.) The Cool Bath (whose temperature is from 60° to about 75°) is analogous in its operation to the cold bath, but less powerful. It is commonly employed for the purposes of pleasure and cleanliness; but it may be resorted to, therapeutically, in the same diseases as the cold bath, where we are in doubt as to the power of the patient's constitution to establish full reaction. It is frequently used as a preparatory measure to the cold bath.

(3.) The Temperate Bath ranges from 75° F. to 85° F. Its effects and uses are similar to the cool bath.

(4.) The Tepid Bath gives rise to a sensation of either heat or cold, according to the heat of the body at the time of immersion. The temperature of this bath ranges between 85° and 92°. It cleanses the skin, promotes perspiration, and is used as preparatory to either of the before-mentioned baths. It is said to allay thirst. Where there is a tendency to apoplexy, it has been recommended to immerse the body in the tepid bath, and at the same time to pour cold water over the head.

(5.) The Warm Bath varies in its effects on different individuals. Its temperature is about that of the body, or a little below it: we may say from 92° to 98°. In general it causes a sensation of warmth, which is more obvious when the body has been previously cooled. It renders the pulse fuller and more frequent, accelerates the respiration, and augments the perspiration. It gives rise to languor, loss of muscular power, faintness, and disposition to sleep. The uses of it are various. Sometimes it is employed to cause relaxation of the muscular system; as in dislocation of the larger joints: and also in hernia, to assist the operation of the taxis. In the passage of calculi, either urinary or biliary, it is applied with the greatest advantage: it relaxes the ducts, and thereby facilitates the passage of the foreign body. As a powerful antiphlogistic, it is employed in inflammation of the stomach, bowels, kidneys, bladder, &c. With the view of increasing the cutaneous circulation, it is used in the exanthemata, when the eruption has reeded,—and to promote perspiration, in chronic rheumatism, and various chronic skin diseases.

(6.) The Hot Bath (the temperature of which is somewhat above that of the body, as from 98° to 112°) gives rise to a sensation of heat, renders the pulse fuller and stronger, accelerates the respiration, occasion intense redness of the skin, and copious perspiration,—causes the vessels of the head to throb violently—brings on a sensation of fulness about the head, with a feeling of suffocation and anxiety,—and, if the immersion be continued, may even induce apoplexy. Being a powerful excitant, it must be used very cautiously. Paralysis, rheumatism, and some chronic diseases, are the principal cases in which it is employed.

(b.) The Vapour Bath.—The vapour bath differs somewhat in its effects-
of the warm or hot bath: hot air and vesicular water being much
more conductors of heat than water in its usual liquid form, the tem-
perature of the bath is neither so quickly, nor so powerfully felt, so that the
body can support a higher heat, and for a longer period; moreover, the
pressure is less. Dr. Forbes (Cyclop. Prac. Med., art. Bathing) gives the
following comparative view of the heating powers of water and of vapour,
distinguishing the latter according as it is or is not breathed:

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<tr>
<th></th>
<th>Water</th>
<th>Vapour</th>
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<tr>
<td></td>
<td>Not breathed.</td>
<td>Breathed.</td>
</tr>
<tr>
<td>Tepid bath</td>
<td>85° — 92°</td>
<td>96° — 106°</td>
</tr>
<tr>
<td>Warm bath</td>
<td>92° — 98°</td>
<td>106° — 120°</td>
</tr>
<tr>
<td>Hot bath</td>
<td>98° — 106°</td>
<td>120° — 160°</td>
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The vapour bath acts as a stimulant to the skin; it excites the cutaneous
circulation, softens and relaxes the tissue, produces copious perscri-
eration, accelerates the pulse, quickens the respiration, and induces
feeling of languor, and a tendency to sleep. There are two modes of
employing it; either by immersing the whole body in the vapour, which
consequently inhaled; or inclosing the body in a chest or box, so that
the head is not exposed to the vapour, which, therefore, is not inspired.
The aqueous vapour is conveyed into the chamber or box by a pipe
communicating with a steam boiler. Sometimes it is made to pass
tough various vegetable substances, with the odour of which it becomes
pregnated, and from which it has been supposed to gain an increase
modification of therapeutical power. These are the medicated vapour
baths. Sometimes the common vapour bath is accompanied by a process
of friction, kneading and extension of the muscles, tendons, and liga-
ments, constituting the massing of the Egyptians, or the sham-
pooing of the Indians. Here is

Fig. 38.

*Fig. 38.*

*Egyptian Bath.*
not dissimilar to what arise from brisk electrical sparks, taken from the joints in quick succession."

The application of vapour to particular parts of the body is sometimes accompanied with the simultaneous removal of atmospheric pressure constituting the *air-pump vapour bath*, which has been employed in cases of gout, rheumatism, and paralysis. I must refer, for a further account of it, to Dr. R. Blegborough's "Facts and Observations respecting the *Air-pump Vapour Bath*.”

The vapour bath is applicable to a great variety of cases, a few only of which can be noticed here. Whenever it is desired to excite the vascular system, more especially the cutaneous portion of it, this remedy may be resorted to with advantage. The cold stage of an intermittent, and malignant cholera, are cases which readily suggest its employment. Rheumatism and gout, in old paralytic cases unaccompanied with signs of vascular excitement about the head, in various atonic affections of the uterine system—such as some forms of chlorosis and amenorrhea, dropsy of old debilitated subjects, in various skin diseases, in scrofula, chronic liver complaints of long standing, &c. this remedy may be employed, and frequently with advantage.

I ought not to leave this subject without alluding to the extensive use made of vapour baths in some parts of the world, particularly Russia, where, we are told, it is customary for the bathers to issue from the bathing-houses while quite hot, and to roll themselves naked in the snow, and then return to the bath, not only without any hurtful, but apparently with beneficial, effects.

β. *Affusion.*—Another mode of employing water externally is by *affusion*; that is, the pouring of water over some portion of the body, as is the ἐκατώπωσις of Hippocrates.

*History.*—This practice is of very ancient date: as a hygienic age and luxury it was practised by the Greeks and Orientalists at a very early period, and allusions to it will be found in the Odyssey of Homer. Hot, tepid, and cold affusions, are mentioned by Celsus, in the fourth chapter of the first book, and are recommended in some affections of the head. This last writer also states, that Cleophahtus (a physician who lived about 300 years before Christ) employed the *affusion* of hot water in intermittents. For an account of the effects and uses of cold affusion, I must refer to the *Medical Reports* of Dr. Currie, and to a paper by Dr. Copland, in the *Medical Gazette*, vol. x.

*Mode of applying affusion.*—In many cases the object is to apply an affusion to the head merely. If the patient be able to sit up, let him incline his head over a large vessel, say a pan or tub, and then pour the water from a height of two or three feet from an ewer or large pitcher. If, however, he be too ill to be removed, he must incline his head on the side of the bed. In children it will be sufficient to squeeze a large sponge at some height above the head, as recommended by Dr. Copland. In some cases it is necessary to guard against the cold water coming into contact with the chest.

When the object is to apply the affusion to the whole body, the patient must be placed in a large tub or pan—for example, a bathing-tub, washing-pan—and then an attendant, standing on a chair, may readily effect it. The time that the affusion should be continued will vary according to circumstances, from a quarter to two or three minutes; but
some cases it has been employed for twenty minutes. After the affusion the body should be carefully wiped dry, the patient wrapped up, and placed in bed.

Effects.—The effects of affusion depend partly on the temperature of water, and partly also on the sudden and violent shock given to the system by the mechanical impulse of the water; hence the reason why the effects vary, according to the height from which the liquid is used.

1. Of the affusion of cold water—that is, of water whose temperature is between 32° F. and 60° F. To a certain extent the effect of this agent is analogous to that of the cold bath, but modified by two circumstances, namely, the short period during which the cold is applied, and the mechanical influence of the stream: hence, its primary effects are very transient, and re-action follows very speedily. By a long continuance of affusion, however, the heat of the body is very considerably reduced, and a same diminution of vital action occurs as when the cold bath is employed. The sensation of cold, the constriction of the skin, and the contraction of the superficial vessels, first experienced in the part to which the water is applied, is very speedily communicated to the rest of the system by sympathy, in consequence of the shock; the effects of which are perceived in the nervous, vascular, secretory, and cutaneous systems. The temperature of the whole body falls, the pulse becomes reduced in volume and frequency, the respiration is irregular, and convulsive shiverings take place, faintness, and, in fact, all the effects already described of the cold bath are produced. During this condition the secretions are suspended. "When," says Dr. Copland, "the stream of water is considerable, and falls from some height upon the head, the effect on the nervous system is often very remarkable, and approaches are nearly than any other phenomenon with which I am acquainted to pro-motive or galvanic agency."

After the affusion, re-action is soon set up, the heat of the body is re-established, the pulse becomes full and regular, though sometimes reduced in frequency, the thirst is diminished, and frequently perspiration and tendency to sleep are observed.

Cold affusion is used principally in those cases where it is considered desirable to make a powerful and sudden impression on the system: for a mere cooling agent it is inferior to some other modes of applying water. Thus it is employed, for the most part, in fevers, and affections of the nervous system. It is objectionable in visceral inflammation, on account of the determination of blood which it produces to the internal parts. Cold affusion has been employed with great benefit in fevers, both continued and intermittent. It may be used with safety, according to Dr. Currie and others, "when there is no sense of chilliness present, then the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration." It is inadmissible during either the cold or the sweating stage of fever, as also in the hot stage, then the heat is not greater than ordinary. In some instances it seems to act by the shock it communicates to the system; for the effect is most immediate, the disease being at once cut short. The patient has lain asleep immediately afterwards, profuse perspiration has succeeded, and from that time recovery begun to take place. This plan of extinguishing a fever, however, frequently fails; and in that event the patient
may be in a worse condition; hence the practice is not often adopted.

think the cases best adapted for the use of cold affusion are those in which there is a great cerebral disorder,—either violent delirium or soporose condition. My friend, Dr. Clutterbuck, (Inquiry into the Sea and Nature of Fever, 2d ed. p. 451), says he has seen pulmonic inflammation and rheumatism brought on by cold affusion in typhus; but he adds, “I have not, in general, observed that the situation of the patient was rendered materially worse by the combination.”

In the exanthemata, cold affusion has been applied during the few weeks which precedes the eruption, as also after this has been established; it has been used in scarlet fever, and also in small-pox; likewise in measles; but its employment in the latter disease is objectionable, on account of the tendency to pulmonary inflammation, in which cold affusion is prejudicial.

Croup is another disease in which cold affusion has been used with advantage, principally with the view of removing the spasm of the glottis, which endangers the life of the patient.

In inflammatory affections of the brain, especially of children, after proper evacuations have been made, it is useful. In many cases of narcotic poisoning, cold affusion is of the greatest service; as in poisoning with hydrocyanic acid, and in asphyxia caused by the inhalation of carbonic acid; so also in poisoning with opium, belladonna, and other narcotic substances, in intoxication, in asphyxia from the inhalation of sulphured hydrogen gas or of the vapours of burning charcoal, the practice is most advantageous. In hysteria and epilepsy it is oftentimes serviceable: it diminishes the duration of the paroxysms, and relieve the comatose symptoms. In puerperal convulsions Dr. Copland relies on cold affusion and blood-letting. In mania it is oftentimes serviceable as also in tetanus.

2. Cool affusion has been employed instead of the cold; and in weak irritable subjects it is always preferable. Dr. Currie regards it as a milder form of the cold affusion, as a preparatory means to which it is sometimes used. It has been applied in febrile diseases and paralysis.

3. Tepid affusion.—The affusion of tepid water is frequently resorted to as a substitute for that of cold water, where great dread is entertained of the latter agent, or where there is doubt as to the production of a perfect reaction after the application of cold water, or where there is some pulmonary disease. It may be regarded as a safer, though less powerful means. Thus it is very useful in febrile complaints, especially of children. It is very beneficial in scarlet fever, as I have seen on several occasions. Dr. Currie thinks that it reduces the temperature more than cold affusion; first, because the evaporation is greater; secondly, because it does not excite that reaction by which heat is evolved. It diminishes the frequency of the pulse and of respiration, and causes a tendency to sleep. The same writer tells us that he has not found it effects so permanent as those of the cold affusion; and that he never saw it followed by the total cessation of regular fever. In other words, it produces a much less powerful shock to the system, and therefore is less influential over disease. In hectic fever, however, the paroxysm is sometimes completely extinguished by the affusion of tepid water at the commencement of the hot stage.

4. Warm affusion excites very pleasant sensations, but which are soon
allowed by chilliness, and oftentimes by pulmonary affections. It has
been used in mania with advantage: it reduces the frequency of the
false and of respiration, and occasions a tendency to repose; but the
effects are much more temporary than those produced by the warm bath.

v. Washing or sponging.—Cold, cool, or tepid washing or sponging,
may be used in febrile diseases, with great advantage, in many cases
where affusion is not admissible, or where timidity on the part of
the patient or practitioner prevents the employment of the latter. Dr.
Murie remarks, that in all cases of fever where the burning heat of the
fims of the hands and soles of the feet is present, this method of cool-
ing them should be resorted to. A little vinegar is frequently mixed
with the water, to make the effect more refreshing. Washing or spon-
ging must be effected under precisely the same regulations as those already
set down for affusion.

6. Shower bath.—The shower bath is similar in its effects to affusion,
but milder in its operation, and is mostly employed in chronic diseases,
as a hygienic agent. In various affections of the nervous system,
more especially insanity, it is very useful. In many cases it is a valuable
agent when we are afraid to venture on the common cold bath or cold
fusion, since it is less likely to cause cramps or other symptoms indica-
tive of a disordered state of the nervous system.

5. The Douche.—The French word douche, or the Italian doccia,
signifies a continued current of fluid applied to, or made to fall on, some
part of the body. Dr. Parr states that it is synonymous with our word
pumping," and with the Latin word stillicidium. At Bath, for example,
the waters are applied, say to a paralyzed part, by means of a pump, and
the degree or quantity of the application is determined by the number of
times the handle is raised or depressed. The water, however, does not
sue in gushes, but in a continuous stream. This is evidently what the
French would call a douche, but our word "pumping" is not applicable
to a "douche de vapeur." According to the direction in which the water
applied we have the douche descendante, douche latérale, and douche
ascendante.

History.—It is uncertain at how early a period this remedy was in
use. The following passage from Cælius Aurelianus has been supposed
by some to refer to this mode of employing water. "Item aquarum
unis partes in passione constitute sunt subjiciendae, quas Græci
ακλυσμονεις appellant, plurimum etinim earum percussiones corporum
ciunt mutationem." By others, however, this passage is supposed to
refer to affusion.

General operation.—The effects of the douche depend on several cir-
cumstances; such as the nature of the fluid employed, whether vapour
is liquid, and if liquid, whether simple or some saline water; the tem-
perature also must have an influence, as is very evident,—the size and
direction of the jet, the force with which it is applied, and its duration.
At Bath, Dr. Falconer tells us, "from 50 to 200 strokes of the pump is
the number generally directed to be taken at one time, which, however,
may be increased or diminished according to the age, sex, strength, or
other circumstances of the patient." On the continent it is rarely em-
ployed for a longer period than 15 or 20 minutes.

The vapour douche is nothing more than a jet of aqueous vapour
directed on some part of the body, its action depending principally on
the temperature of the fluid, since its mechanical effects are comparatively slight. In the common vapour douche the temperature of the aqueous vapour does not exceed that employed in the vapour bath already described; and in such cases it may be regarded as a kind of local vapour bath. Thus in some affections of the ear, as otitis, otorrhcea and otalgia, a stream of aqueous vapour may be applied to the means auditorius externus with great benefit; and the most ready means of effecting this is by a funnel inverted over a vessel of hot water, the ear being placed over the orifice of the funnel.

Sometimes steam has been used—that is, aqueous vapour heated to 212° F.; and, of course, it acts as a caustic if sufficiently long applied, causing sometimes an extensive and deep eschar. In this respect its action is similar to that of boiling water, from which, indeed, it principally differs in the circumstance of having a much larger quantity of specific heat, and in the great facility with which we can localize its effects. It may be readily applied to any part of the body by means of a small boiler (copper or tin), furnished with a pipe and stop-cock, and heated by a spirit lamp. It has been used as a powerful counter-irritant in diseases of the hip-joint, neuralgic pains, chronic rheumatism, &c., but the objections to its use are the great pain and the danger of its employment; for it is a more painful application than many other modes of causing counter-irritation, while its effects are inconstant.

The action of the liquid douche depends in a great measure on the temperature of the liquid, but in part also on the mechanical action of the water. This effect of percussion is common to both the cold and hot douche, and by contiguity excites pain and inflammation of the part. This local excitement is observed almost immediately when hot water is employed, but takes place more slowly when we use cold water; indeed, the long action of a stream of cold water may act as a sedative, and cause all the effects which I have already described as the primary effects of cold applications.

The effect of the douche is, however, not altogether local, since the neighbouring parts, and even the whole animal economy, soon become affected. A column of water twelve feet high, made to fall perpendicularly on the top of the head, excites such a painful sensation, that, we are told, the most furious maniacs who have once tried it may sometimes be awed merely by the threat of its application; and hence one of its uses in madness, as a means of controlling the unfortunate patient.

The cold douche is applicable to those cases of local disease requiring a powerful stimulus. For example, chronic affections of the joints, of long standing, whether rheumatic, gouty, or otherwise, paralytic affections of the limbs, old glandular swellings, and those forms of insanity in which there are no marks of determination of blood to the head. The warm douche may be employed in similar cases.

For a variety of local purposes, a syringe is employed to throw a jet of water on particular parts, as into sinuous ulcers, or into the vagina, into the ear, into the rectum, &c., constituting thus a kind of douche.

ζ. Local uses.—Hot, warm, and cold water, applied to particular parts of the body, may be regarded as local baths. Cold water is applied to produce evaporation, and thereby to generate cold, with the view of relieving local irritation and inflammation. In ophthalmia, phrenitis, and even in gout (though in the latter complaint the practice has been
lected to), cold water lotions are employed with great advantage. One method of treating burns is by the application of cold water, and, if I am to judge by my own sensations, it is by far the most agreeable. By me, however, warm water is employed as an emollient application in burns and scalds. This is the practice of my friend Mr. Luke, one of the surgeons to the London Hospital. (Med. Gaz. vol. xviii. p. 7).

*Warm fomentations and poultices* (made of bread or linseed meal) may be regarded, in reference to their effects, as a local bath.

*Boiling water* is employed externally as a powerful irritant and a ready vesicant; its action being in this respect analogous to steam, readily noticed, and objectionable on the same ground, namely, the great heat, and the uncertainty of its effects; in addition to which may be mentioned, the difficulty of localizing its action. When applied in diseases of internal organs, it may be regarded as a powerful counter-irritant.

III. **Pharmaceutical Uses.**—Water is frequently employed in pharmacy for extracting the active principles of various medicinal plants. The solutions thus procured are termed, by the French re-formers of pharmaceutical nomenclature, *hydrolicus* or *hydrolica* (Pharm. nomenclat. of MM. Chereau and Henry, in the Supplement to the *Pharm. New Dispens.* p. 152). Those prepared by solution or mixture, called *hydroles*; and others, procured by distillation, are denominated *hydrats*.

11. **Hydroles.**—Cottereau (Traité Elém. de Pharmacologie, 1835), divides these into three classes; *a.* Mineral *hydroles* (*hydroles chimico-siques*), of which Goulard-water and lime-water are examples; *β. vegetable hydroles* (*hydroles phytobasiques*), as almond emulsion, mucilage, vegetable infusions, and decoctions, &c.; *γ. animal hydroles* (*hydroles zoobasiques*), as broths.

12. **Hydrats.**—These are the *aqua distillatae* of the British Pharmacopoeias: as *aqua menthae piperitae*, called, in the French codex, *hydromun menthae piperitae*.

*A'que Miner'a'les.—Mineral Waters.*

**History.**—Mineral waters were known to mankind in the most remote periods of antiquity, and were employed, medicinally, both as external and internal agents. Homer (Iliad, xxii. 147) speaks of tepid and cold springs. The Asclepiadæ, or followers of Æsculapius, erected their temples in the neighbourhood of mineral and thermal waters (Sprengel, *St. de Médec. par Jourdan*, t. 1er, p. 144). Hippocrates (De aeribus, *aer, locis*) speaks of mineral waters, though he does not prescribe them even speaking of particular diseases. Pliny (Hist. Nat. lib. xxxi.) notices their medical properties.

**Natural History.**—The principal source of mineral waters is the atmosphere, from which water is obtained in the form of rain, snow, hail, and dew, and which after percolating a certain portion of the earth, dissolving various substances in its passage, reappears on the surface at the bottom of declivities (spring water), or is procured by sinking wells (well water). But springs are sometimes observed under circumstances which are inconsistent with the supposition of their atmospheric origin. "The boiling springs which emerge on the verge of perpetual snows, at an altitude of 13,000 feet above the level of the
sea, as in the Himalayans, cannot be derived from the atmosphere, not to mention the peculiar relations of the Icelandic Geysers” (Gairdner, *Essay on Mineral and Thermal Springs*, p. 289). Other sources, therefore, have been sought for, and the writer just quoted enumerates these: viz. the focus of volcanic activity, the great mass of the ocean, or other masses of salt-water, and subterranean reservoirs.

Considered with reference to their temperature, mineral waters are divided into cold and hot. The hot or thermal waters are those which possess a temperature more or less elevated above the mean of the latitude or elevation at which they are found, and the changes of which, with any, observe no regular periods coincident with the revolutions of the seasons. Three causes have been assigned as the source of the heat of mineral waters; viz. volcanic action, now extinct; volcanic action, now extinguished, but the effects of which still remain; and, as the central cause of heat, which increases as we descend from the surface to the interior of the earth (Gairdner, *op. cit.*).

The Geysers, or boiling springs, of Iceland, are evidently connected with volcanic action. They are intermittent fountains which throw up boiling water and spray to a great height into the air. For further information concerning them, I must refer you to Sir G. S. Maekenzie’s “Travels in Iceland during the Summer of 1810,” and to Barrow’s “Visit to Iceland, by way of Tronyem &c., in the Summer of 1834.”

Fig. 39.

The origin of the saline and other constituents is another interesting topic of inquiry connected with the natural history of mineral springs. As water in its passage through the different strata of the earth comes in contact with various substances which are soluble in it, we refer certain constituents of mineral waters to solution and lixiviation merely as chloride of sodium, carbonates of lime and magnesia, iodides and bromides of sodium and magnesium, iron, silica, &c. Chemical action must, in some cases, be the source of other constituents. The sulphuretted hydrogen is probably produced by the action of water on some metallic sulphur (especially nonpyrites): sulphurous and sulphuric acid, from the oxidation and combustion of sulphur, free or combined. The carboxylic acid found in the acidulous or carbonate waters is referrible to the decomposition of carbonate of lime, either by heat or by the action of sulphuric acid. Hydrochloric acid is doubtless produced by the decomposition of some chloride or muriate (probably chloride of sodium or sal ammoniac). Carbonate of soda must also be considered as the product of some chemical process; thus, that found in the natron lakes of Egypt is supposed to be formed by the action of chloride of sodium on carbonate of lime (Bertholett, *Essai de Statique Chimique*, 1er. part. p. 406). 

“The different orifices of the Karlsbad Sprudel discharge annually about 13,000 tons of carbonate of soda, and 20,000 of the sulphate in the crystallized state” (Gairdner, *op. cit.* p. 325): but “very simple calculation is sufficient to show, that the Donnerschewald alone, the loftiest of the Bohemian Mittelgebirge, a cone of clinkstone
500 feet in elevation, contains soda enough to supply the Karlsbad waters alone for more than 30,000 years." (Ibid. p. 338).

DIVISION AND PROPERTIES.—Mineral waters may be classified according to their temperature, their chemical composition, or their medicinal properties. But hitherto no satisfactory classification has been effected by any of these methods, nor perhaps can it be formed. The most convenient arrangement is that founded on chemical composition, and which consists in grouping mineral waters in four classes.

Class 1. Chalybeate, ferruginous, or martial waters. (Aque minerales ferruginose; aquæ martiales).—Oxide of iron is a constituent of most mineral waters, and when the quantity is considerable, the term chalybeate is applied to them. Chalybeate waters have anky, styptic taste, and the property of becoming purplish black on the addition of tannic or gallic acids, or of substances which contain these, the infusion of galls or of tea. If the iron be in the state of sesquioxide, the ferrocyanide of potassium causes a blue, and sulphocyanide potassium a red colour.

Most chalybeate waters contain the carbonate of the protoxide of iron; and are termed carbonated-chalybeates. Such waters, when exposed to the air, evolve carboxic acid, attract oxygen, and deposit the sesquioxide of iron. By boiling also, the whole of the iron may be precipitated as sesquioxide. When the proto carbonate of iron is associated with a considerable quantity of free carboxic acid, the waters are termed acidulous-carbonated-chalybeates, or simply acidulous-chalybeates; as the carbonated waters of Spa in Belgium. When a carbonated-chalybeate contains alkaline and earthy salts, but not much free carboxic acid, it is termed a saline-carbonated-chalybeate; as the waters of Tunbridge Wells, Hy's saline chalybeate at Harrowgate, and the Islington Spa near London.

In some cases the oxide of iron is in combination with sulphuric acid: these waters might be termed, in contradistinction to the above, sulphated-chalybeates. Exposure to the air, or boiling, does not precipitate the iron, and in this they are distinguished from the carbonated-chalybeates. The sulphated-chalybeates usually contain sulphate of urina, and, in that case, are termed aluminous-chalybeates: of these, Sand Rock Spring, Isle of Wight, the strong Moffatt Chalybeate, and Vicar's Bridge Chalybeate, are examples: the last-mentioned is probably the strongest chalybeate in existence.

The effects of chalybeate waters are analogous to those of other ferruginous compounds which I shall have occasion to notice in a subsequent part of this work, and to which, therefore, I must refer for their information. I may, however, mention here that these waters are acic, stimulant, and astringent, and produce blackening of the stools. The acidulous-carbonated-chalybeates sit more easily on the stomach than other ferruginous agents, in consequence of the excess of carbonic acid present. The aluminous-chalybeates are very apt to occasion colic, especially if taken in the undiluted state.

The use of this class of waters is indicated in cases of debility, especially when accompanied with that state of system denominated anaemia, contra-indicated in plethoric, inflammatory, febrile, and hemorrhagic dispositions.

Class 2. Sulphureous or hepatic waters. (Aque minerales l.
sulphureæ seu hepaticæ).—These waters are impregnated with hydrosulphuric acid (sulphuretted hydrogen); in consequence of which they have the odour of rotten eggs, and cause black precipitates (metallie sulphures) with solutions of the salts of lead, silver, copper, bismuth, &c. Those sulphureous waters which retain, after ebullition, their power of causing these precipitates, contain a sulphuret (hydrosulphuret) in solution, usually of ealeium or sodium. All the British sulphureous waters are cold, but some of the continental ones are thermal. The most celebrated sulphureous waters of England are those of Harrowgate; those of Scotland are Moffatt and Rothsay; of the continent, Enghien, Baréges, Aix, and Aix-la-Chapelle.

The general operation of these waters is stimulant. They are supposed to possess a specific power over the cutaneous and uterine systems. They are employed both as external and internal agents; in chronic skin diseases (as lepra, psoriasis, scabies, pityriasis, herpes, &c.)—in derangements of the uterine functions (amenorrhœa and chlorosis)—in old syphilitic cases—in chronic rheumatism and gout, and in other diseases in which sulphur or its compounds have been found serviceable, and which will be noticed hereafter. On account of their stimulant effects, they are contra-indicated in all plethoric and inflammatory conditions of system.

Class 3. Acidulous or Carbonated Waters. (Aqua mineralis acidula).—These waters owe their remarkable qualities to carbonic acid gas, which gives them an acidulous taste, a briskness, a sparkling property, and the power of reddening litmus slightly, but fugaciously, and of precipitating lime and baryta waters. When they have been exposed to the air for a short time, this gas escapes from them, and the waters lose their characteristic properties.

Most mineral and common waters contain a greater or less quantity of free carbonic acid. Ordinary spring and well waters do not usually contain more than three or four cubie inches of carbonic acid gas in 100 cubie inches of water. Dr. Henry found, in one experiment, 3.38 inches (Thomson’s System Chem., vol. iii. p. 193, 6th edit.). But the waters called acidulous or carbonated contain a much larger quantity. Those which have from 30 or 60 cubie inches of gas are considered rich but the richest have from 100 to 200 or more cubie inches (Gairdner, op. cit. p. 30). Alibert (Nouveaux Élémens de Thérapeutique, tom. 3me. p. 517, 5me. ed.) states, that the waters of Saint Nectaire contain 40 cubie inches in 100 of the water. This is the richest of all the acidulous springs.

Some of the waters of this class contain carbonate or bicarbonate of soda: these are termed acidulo-alkaline. Frequently they contain carbonate of the protoxide of iron also.

The only acidulous or carbonated spring in Great Britain is that at Ilkeston, near Nottingham, and which has been described by Mr. A. F. Greeves (Account of the Medicinal Water of Ilkeston, 1833), and by D. T. Thomson (Cyclopedia of Practical Medicine, art. Waters, Mineral).

Those acidulous waters which owe their medicinal activity principally to the carbonic acid which they contain, act chiefly on the digestive and nervous systems, but their effects are transient. They stimulate the stomach and relieve nausea. Sometimes they occasion a sensation of fulness in the head, or even produce slight temporary intoxication. The
used in some disordered conditions of the digestive organs, especially when connected with hepatic derangement, in dropsical complaints, in uric affections, and in various other cases, which will be more fully noticed when treating of carbonic acid. When the acidulous waters contain the protocarbonate of iron, their effects and uses are analogous to use of the ferruginous springs already noticed. The acidulo-alkaline waters are useful in the lithic acid diathesis, in gout and rheumatism, &c. Acidulous or carbonated waters are objectionable, on account of their mutuel effects, in febrile, inflammatory, and plethoric subjects.

Class 4. Saline Mineral Waters (Aquae minerales salinae).—These waters owe their medicinal activity to their saline ingredients; for though they usually contain carbonic acid, and sometimes oxide of iron and hydrosulphuric acid, yet these substances are found in such small quantities as to contribute very slightly only to the medicinal operations of the water.

Saline mineral waters may be conveniently divided into five orders, named on the nature of the predominating ingredient.

Order 1. Purging saline waters.—The leading active ingredient of these waters is chloride of sodium. Iodine or bromine has been recognized in some of them, and doubtless contributes somewhat to the medicinal effects. The most important brine springs of England are those of Middleswich and Nantwich, in Cheshire; Shirleywich, in Staffordshire, and Droitwich, in Worcestershire. The springs of Ashby-de-la-Zouch, Leicestershire, contain, besides chloride of sodium, a considerable quantity of chloride of calcium. Taken in large quantities, saline or brine waters are emetic and purgative. In small but continued doses they act as refrigerants and alteratives. They are useful in diseased fever, dropsical complaints, habitual constipation, hemorrhoids, determination of blood to the head, &c.

Order 2. Saline or brine waters.—The characteristic ingredient of these waters is chloride of sodium. Iodine or bromine has been recognized in some of them, and doubtless contributes somewhat to the medicinal effects. The most important brine springs of England are those of Middleswich and Nantwich, in Cheshire; Shirleywich, in Staffordshire, and Droitwich, in Worcestershire. The springs of Ashby-de-la-Zouch, Leicestershire, contain, besides chloride of sodium, a considerable quantity of chloride of calcium. Taken in large quantities, saline or brine waters are emetic and purgative. In small but continued doses they act as alteratives, and are supposed to stimulate the absorbent system. They have been principally celebrated in glandular enlargements, especially those which are of a scrophulous nature.

Order 3. Calcareous waters.—Those saline mineral springs whose dominating constituent is either sulphate or carbonate of lime, or both, are denominated calcareous waters. The Bath, Bristol, and Buxton mineral waters are of this kind. When taken internally, their usual effects are stimulant (both to the circulation and the urinary and cutaneous secretions), alterative, and constipating; and are referrible, in part, to the temperature of the water, in part to the saline constituents. Employed as baths they are probably not much superior to common water heated to the proper temperature; but they have been much celebrated for the cure of rheumatism, chronic skin diseases, &c. Bath water is generally employed both as a bath and as an internal medicine in various chronic diseases admitting of, or requiring, the use of a gentle but con-
tinued stimulus; as chlorosis, hepatic affections, gout, rheumatism, lepra, &c. Buxton water, taken internally, has been found serviceable in dis
ordered conditions of the digestive organs, consequent on high indul
gence and intemperance; in calculous complaints, and in gout: em
ployed externally, it has been principally celebrated in rheumatism. The
water of Bristol Hotwell is taken in dyspeptic complaints and pulmonary
consumption.

Order 4. Alkaline waters.—The mineral waters denominated alkaline
contain carbonate or bicarbonate of soda as their characteristic ingredient.
They pass insensibly into, and are, therefore, closely related to, the waters
of the preceding classes. Thus springs which contain carbonate of soda
with a considerable excess of carbonic acid (as those of Carlsbad and Scher
zer), are denominated acidulo-alkaline, and are classed with the acidulo-
or carbonated waters. Those in which carbonate of soda is associated with
protocarbonate of iron and excess of carbonic acid (as Spa water), are
termed chalybeate waters. The only waters in this country which con
tain carbonate of soda are those of Malvern, in Worcestershire; and Ilkes
ton, in Derbyshire, near Nottingham; but the quantity in both cases is
very small. The first, which is a very pure water, contains only 0.6
parts of the carbonate in 10,000 of the water, and the second 3.33
grains in an imperial gallon. For external use the alkaline waters are
principally valuable on account of their detergent qualities. When taken
internally they act on the urinary organs. They may be employed in
calculous complaints connected with lithic acid diathesis, in gout, in
dyspepsia, &c.

Order 5. Siliceous waters.—Most mineral waters contain traces of
silica, but some contain it in such abundance that they have been deno
minated siliceous. Thus in the boiling springs of Geysir and Reikon, in
Iceland, it amounts to nearly one-half of all the solid constituents. In
these waters the silica is associated with soda (silicate of soda) sulphat
of soda, and chloride of sodium (See Dr. Black’s analysis, in the Trans
Royal Soc. Edin. vol. iii.: also Faraday’s, in Barrow’s Visit to Iceland).
I am unacquainted with their action on the body. It is probably similar
to that of the alkaline waters.

Acidum Hydrochlo’ricum.—Hydrochlo’ric Acid.

History and Synonymes.—Liquid hydrochloric acid was probably
known to Geber, the Arabian chemist, in the eighth century. The pre
sent mode of obtaining it was contrived by Glauber. It has been know
by the various names of spirit of salt, marine acid, and muriatic acid.
Some modern chemists term it chlorohydric acid. Scheele, in 1774, ma
be regarded as the first person who entertained a correct notion of the
composition of hydrochloric acid. To Sir H. Davy we are principally
indebted for the establishment of Scheele’s opinion.

Natural History.—It is found in both kingdoms of nature.

(a.) In the inorganized kingdom.—Hydrochloric acid is one of the
gaseous products of volcanoes. Combined with ammonia, we find it in
volcanic regions.

(b.) In the organized kingdom.—Free hydrochloric acid is an essential
constituent of the gastric juice in the human subject. Hydrochlorate of
ammonia (sal ammoniac) was found, by Berzelius, in the urine. Chevre
states he detected free hydrochloric acid in the juice of Isatis tinctoria.
1. Gaseous Hydrochloric Acid.

Preparation.—Hydrochloric acid, in the gaseous state, is procured by the action of strong liquid sulphuric acid on dried chloride of sodium. The ingredients should be introduced into a tubulated retort, and the gas collected over mercury. Or they may be placed in a clean and dry flask, and the gas conveyed, by means of a glass tube curved twice at right angles, into a proper receptacle, from which the gas expels the air of its greater gravity.

In this process, one equivalent, or 60 parts of chloride of sodium, react with one equivalent, or 49 parts of the protohydrate of sulphuric acid (strong oil of vitriol), and produce one equivalent, or 37 parts of hydrochloric acid (gas), and one equivalent, or 72 parts of the sulphate of soda.

**Ingredients Used.**

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<thead>
<tr>
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<tbody>
<tr>
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<td>97.297</td>
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<td>Sodium</td>
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<td>Hydrochloric acid</td>
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<td></td>
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<td>Liquid</td>
<td>9</td>
<td>40</td>
<td>10,000</td>
<td>Hydrochloric Acid gas</td>
<td>2</td>
</tr>
</tbody>
</table>

**Products.**

1 eq. Hydrochloric Acid = 37

**Properties.—** It is a colourless invisible gas, fuming in the air, in consequence of its affinity for aqueous vapour. It is rapidly absorbed by water. Its specific gravity is, according to Dr. Thomson, 1.2847. It has a pungent odour and acid taste. Under strong pressure (40 atmospheres) it becomes liquid. It is neither combustible nor a supporter of combustion. When added to a base (that is, a metallic oxide), water and a chloride are the results.

**Characteristics.—** Hydrochloric acid gas is known by its fuming in the air, by its odour, by its reddening moistened litmus paper, and by forming white fumes with the vapour of ammonia, and by the action of nitrate of silver on an aqueous solution of the gas, as will be mentioned when describing the liquid acid.

**Composition.—** The composition of this gas is determined both by analysis and synthesis. Thus, one volume of chlorine gas may be made to combine with one volume of hydrogen gas, by the aid of light, heat, electricity, and the resulting compound is two volumes of hydrochloric acid gas. Potassium or zinc heated in this acid gas, absorbs the chlorine and leaves a volume of hydrogen.

**Physiological Effects.—**

(a) On vegetables.—Mixed with 20,000 times its volume of atmospheric air, this gas is said by Drs. Christison and Turner (Christison’s Treatise on Poisons) to have proved fatal to plants, shrivelling and killing all the leaves in twenty-four hours. But, according to Messrs. Rogerson (Medical Gazette, vol. x. p. 312) it is not injurious to vegetables when mixed with 1500 times its volume of air. Dr. Christison ascribes these different results to Messrs. Rogerson.
having employed glass jars of too small size. We have good evidence of the poisonous operation of this gas on vegetables in the neighbourhood of those chemical manufactories in which carbonate of soda is procured from common salt. The fumes of the acid which issue from these works have proved so destructive to the surrounding vegetation, that in some instances the proprietors have subjected themselves to actions at law, and have been compelled either to pay damages, or to purchase the land in their immediate neighbourhood.

(b.) On animals this gas acts injuriously, even when mixed with 150 times its volume of atmospheric air. Mice or birds introduced into the pure gas struggle, gasp, and die, within two or three minutes. Diluted with atmospheric air, the effects are of course milder, and in a ratio the quantity of air present. In horses it excites cough and difficulty breathing. When animals are confined in the dilute gas, in addition the laborious and quickened respiration, convulsions occur before death. Messrs. Rogerson state, that "in a legal suit for a general nuisance tried at the Kirkdale Sessions-house, Liverpool, it was proved that horses, cattle, and men, in passing an alkali-works, were made, by inhaling the gas, to cough, and to have their breathing much affected. In the case of Whitehouse v. Stevenson, for a special nuisance, lately tried at the Staffordshire assizes, it was proved that the muriatic acid gas from a soap manufactury destroyed vegetation, and that passengers were seized with a violent sneezing, coughing, and occasional vomiting. One witness stated, that when he was driving a plough, and saw the fog, he was obliged to let the horses loose, when they would gallop away till they got clear of it." It acts as an irritant on all the mucous membranes.

(c.) On man this gas acts as an irritant poison, causing difficult respiration, cough, and sense of suffocation. In Mr. Rogerson's case, it caused also swelling and inflammation of the throat. Both in man and animals it has appeared to produce sleep.

The action of hydrochloric acid gas on the lungs is injurious in at least two ways: by excluding atmospheric air, it prevents the decarbonization of the blood; and, secondly, by its irritant, and perhaps also by its chemical properties, it alters the physical condition of the bronchial membrane. The first effect of attempting to inspire the pure gas seems to be a spasmodic closure of the glottis. Applied to the conjunctiva, causes irritation and opacity.

Use.—It has been employed as a disinfectant, but is admitted on hands to be much inferior to chlorine. The Messrs. Rogerson deny that it possesses any disinfecting property. It is perhaps equally difficult to prove or disprove its powers in this respect. The experiments of Guyton Morveau, in purifying the cathedral of Dijon, in 1773, are usually referred to in proof of its disinfecting property. If it possess powers of this kind, they are certainly inferior to chlorine, or the chlorides of lime and soda; but, in the absence of these, hydrochloric acid gas may be tried. In neutralizing the vapour of ammonia it is certainly powerful.

Application.—In order to fumigate a room, building, or vessel, with this gas, pour some strong sulphuric acid over dried common salt, placed in a glass capsule or iron or earthen pot, heated by a charcoal fire.

Antidote.—Inhalations of the vapour of ammonia may be serviceable in neutralizing hydrochloric acid gas. Symptoms of bronchial inflammation are of course to be treated in the usual way.
2. Liquid Hydrochloric Acid.

SYNONYMS.—This is an aqueous solution of hydrochloric acid, and is usually called, for brevity, hydrochloric or muriatic acid. It is the acidum hydrocholoricum of the London Pharmacopoeia.

PREPARATION.—(a.) According to the Pharmacopoeias. In the London Pharmacopoeia this acid is prepared by adding twenty ounces of sulphuric acid mixed with twelve fluid ounces of distilled water, to two pounds of dried chloride of sodium, placed in a glass retort. Twelve fluid ounces of distilled water are to be put into the receiver. Distil by a sand bath. In the Dublin Pharmacopoeia a somewhat larger quantity of water is employed. The Edinburgh Pharmacopoeia orders equal weights of sulphuric acid, water, and chloride of sodium (previously heated to redness). (b.) In commerce.—Manufacturers of hydrochloric acid generally employ an iron or stoneware pot set in brickwork over a fire-place, with a stoneware head luted to it, and connected with a row of double-necked bottles, made of the same material, and furnished with stop-cocks of earthenware. The last bottle supplied with a safety tube, dipping into a vessel of water (fig. 40).

Since the manufacture of carbonate of soda from the sulphate of soda, and the consequent necessity of obtaining the latter salt in large quantities, another mode of making hydrochloric acid has been adopted. It consists in using a semi-cylindrical vessel for the retort: the upper or flat surface of which is made of stone, while the curved portion exposed to the fire is formed of iron. The chloride of sodium is introduced at one end, which is then closed by an iron plate, perforated to allow the introduction of the leg of a curved leaden funnel, through which strong sulphuric acid is poured. The funnel is then removed, and the aperture closed. Heat being applied, the hydrochloric acid gas is developed, and conveyed by a pipe into a double-necked stoneware bottle, half filled with water, and connected with a row of similar bottles, likewise containing water. The gas dissolves in the water, which, when saturated, constitutes the common yellow hydrochloric acid of commerce, which is coloured by iron. By a second distillation, at a low heat, a liquid nearly colourless is obtained, which is sold as pure hydrochloric acid.

The theory of the above process is precisely that already explained in the manufacture of hydrochloric acid gas. The salt is dried, to expel any water which may be mechanically lodged between the plates of the crystal, and to obtain uniform weights. The Edinburgh
College order the chloride to be heated to redness, to decompose any nitrate which which may be present; and, in order to insure the complete decomposition of the salt, employ a large excess of sulphuric acid, so that the residual salt is the bisulphate of soda.

Properties.—Pure liquid hydrochloric acid is colourless, evolves acid fumes in the air, and possesses the usual characteristics of a strong acid. It has the odour and taste of the gaseous acid. Its specific gravity varies with its strength. That of the London Pharmacopoeia is 1·16. It is decomposed by some of the metals (as zinc and iron), hydrogen gas being evolved, while a chloride is formed in solution. It is decomposed by those oxyacids which contain five atoms of oxygen—namely, nitric, chloric, iodic, and bromic acids: the oxygen of these acids unites with the hydrogen of the hydrochloric acid to form water. It combines with ammonia, as well as with the vegetable alkalies, to form a class of salts called hydrochlorates or muriates. When it acts on a metallic oxide and a chloride arc generated.

Characteristics.—A solution of nitrate of silver causes, with hydrochloric acid, a precipitate of the chloride of silver. This precipitate is known to be the chloride by its whiteness, its clotty or curdy appearance, its blackening by exposure to light, its insolubility in nitric acid, its solubility in ammonia, and by its fusibility (see p. 105). When pure, hydrochloric acid neither dissolves leaf gold, nor destroys the colom of sulphate of indigo. The addition of a few drops of nitric acid readily enables it to dissolve gold. A rod dipped in a solution of caustic ammonia produces white fumes when brought near strong liquid hydrochloric acid.

Composition.—At the temperature of 40° F. water absorbs 480 times its bulk of hydrochloric acid gas, and forms a solution, having a specific gravity of 1·2109 (Sir H. Davy’s Elements of Chemical Philosophy, p. 252). Prepared according to the London Pharmacopoeia, liquid hydrochloric acid has a sp. gr. of 1·16, and contains about a third of its weight of hydrochloric acid gas.

<table>
<thead>
<tr>
<th>Sp. gr. of liquid acid.</th>
<th>Hydrochloric acid gas in 100 of liquid.</th>
<th>Authority.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1·16</td>
<td>32·32</td>
<td>Mr. E. Davy.</td>
</tr>
<tr>
<td>1·162</td>
<td>33·945</td>
<td>Dr. Thomson.</td>
</tr>
<tr>
<td>1·1620</td>
<td>32·621</td>
<td></td>
</tr>
<tr>
<td>1·1641</td>
<td>33·029</td>
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</tr>
<tr>
<td>1·1661</td>
<td>33·437</td>
<td>Dr. Ure.</td>
</tr>
<tr>
<td>1·1681</td>
<td>33·845</td>
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</tbody>
</table>

100 grains of liquid hydrochloric acid sp. gr. 1·16 should saturate 132 grains of crystallized carbonate of soda. A better substance for ascertaining the strength of the acid is pure Carrara marble (carbonate of lime): every 50 grains dissolved indicates 37 grains of real hydrochloric acid.

The Acidum hydrochloricum dilutum of the London Pharmacopoeia is composed of four fluid ounces of the strong liquid hydrochloric acid, and twelve fluid ounces of water. One fluiddrachm of it saturates very nearly 32 grains of crystallized carbonate of soda (Phillips, Translation of the Pharmacopoeia).

Impurities.—The ordinary impurities of the common liquid hydrochloric acid of the shops are perchloride of iron, sometimes a little free chlorine, and occasionally a little sulphuric acid. Dr. T. Thomson
spects that bromine may be present, partly because this substance has
en found in common salt, and partly because a small quantity of this
stance gives a yellow colour to pure hydrochloric acid.
The presence of iron is shown by saturating the acid with carbonate
soda, and then applying tincture of nutgalls, which produces a black
Another mode is to supersaturate the liquid with ammonia or its
bicarbonate, by which the red or sesquioxide of iron will be pre-
pitated.
If the liquid acid contain either free chlorine (or bromine) it will pos-
the power of dissolving leaf-gold, or even of decolorizing a small
antity of sulphate of indigo. A solution of protochloride of tin pro-
ces a purplish colour with a solution of gold.
Sulphuric acid (free or combined) may be detected by adding to the
pected acid a solution of chloride of baryum: if sulphuric acid be
sent, a heavy white precipitate of sulphate of baryta is procured,
ich is insoluble in both acids and alkalies. In applying this test the
pected acid should be previously diluted with five or six times its
ume of water; otherwise a fallacy may arise from the crystallization
the chloride of baryum.

Physiological effects.—(a.) On dead animal matter.—Very dilute
drochloric acid, mixed with dried mucons membrane, has the pro-
ty of dissolving various animal substances (as coagulated albumen,
in of the blood, boiled meat, &c.), and of effecting a kind of artificial
estion of them, somewhat analogous to the natural digestive process—
iller, Elements of Physiology, p. 544).

(b.) On living animals.—The effects of liquid hydrochloric acid on
ing animals (horses and dogs) have been investigated by Sproegel,
nton, Viborg (Wibmer, die Wirkung der Arzneimittel und Gifte), and
Orfila (Toxicologic Générale). Thrown into the veins it coagulates
blood, and causes speedy death. Small quantities, however, may be
ected without giving rise to fatal results. Thus Viborg found that a
se recovered in three hours from the effects of a drachm of the acid
ated with two ounces of water, thrown into a vein. Administered
the stomach to dogs, the undiluted acid acts as a powerful caustic
son. Exhalations of the acid vapours take place through the mouth
 nostrils, and death is generally preceded by violent convulsions.
(c.) On man.—Properly diluted, and administered in small but repeated
es, hydrochloric acid produces the usual effects of a mineral acid
ere described (pp. 80, 81, and 84): hence it is tonic, refrigerant, and
etic. It usually causes a sensation of warmth in the stomach, relaxes
bowels, and increases the frequency of the pulse. Larger doses
said to have excited giddiness and a slight degree of intoxication or
or. In a concentrated form it operates as a powerfully caustic poison.
only recorded case of poisoning by it (in the human subject) with
ich I am acquainted, is that mentioned by Orfila (Toxicolog, Générale).
particular nature of the chemical changes effected by it in the organic
ues with which it comes in contact, is not so well understood as in
ese of sulphuric or nitric acid. Its chemical action is less energetic
either of the acids just mentioned.

Uses—(a.) Internal or remote.—Hydrochloric acid has been employed	hose diseases formerly supposed to be connected with a putrescent
dition of the fluids; as the so-called putrid and petechial fevers,
malignant scarlatina, and ulcerated sore throat. It is usually administered, in these cases, in conjunction with the vegetable tonics; as cinchona or quassia. We frequently employ it to counteract phosphatic deposits in the urine. After a copious evacuation, it is, according to Dr. Paris, the most efficacious remedy for preventing the generation of worms; for which purpose the infusion of quassia, stronger than that of the Pharmacopoeia, is the best vehicle. It has been employed with benefit in some forms of dyspepsia. Two facts give a remarkable interest to the employment of this acid in dyspeptic complaints; namely, that it is a constituent of the healthy gastric juice; and, secondly, when mixed with mucus, it has a solvent or digestive power in the case of various articles of food, as before mentioned. Lastly, hydrochloric acid has been used in scrofulous and venereal affections, in hepatic disorders, &c.

(b.) External.—In the concentrated form it is employed as a caustic to destroy warts, and as an application in sloughing phagedena, though for the latter purpose it is inferior to nitric acid. Properly diluted it forms a serviceable gargle in ulceration of the mouth and throat. The objection to its use as a gargle is its powerful action on the teeth: to obviate this as much as possible, the mouth is to be carefully rinsed each time after using the gargle. It is sometimes applied to ulcers of the throat by means of a sponge. Water acidulated with this acid has been applied to frostbitten parts, to chilblains, &c. An injection composed of from 8 to 12 drops of the acid to three or four ounces of water, has been employed as an injection in gonorrhoea.

Administration.—It is given, properly diluted, in doses of from five to fifteen or twenty minims. The diluted acid of the Pharmacopoeia may be administered in doses of from half a fluidrachm to one fluidrachm. The most agreeable mode of exhibiting it is in the infusion of roses using the hydrochloric instead of sulphuric acid.

Antidotes.—In a case of poisoning by this acid, the antidotes are chalk, whitew, magnesia or its carbonate, and soap; and in the absence of these, oil, the bicarbonated alkalies, milk, white of egg, or demulcients of any kind. Of course the gastro-enteritis is to be combated in the usual way.

Order 6.—Nitrogen, and its Compounds with Oxygen and Hydrogen.

Nitrogenium.—Nitrogen.

History and Synonymes.—This gas was first recognised by Dr. Rutherford, in 1772. He termed it mephitic air. Priestley called it phlogistated air. Lavoisier, azote (azo'tum). Cavendish, finding it to be a constituent of nitric acid, gave it the name it now usually bears (nitrogen).

Natural History.—It is found in both kingdoms of nature.

(a.) In the inorganized kingdom.—It has not hitherto been found in non-fossiliferous rocks. It is a constituent of coal, of nitrates, of ammniacal salts, and of some mineral waters. It forms 79 or 80 per cent. of the atmosphere.

(b.) In the organized kingdom.—It is a constituent of various vegetable principles, as the organic alkalies, gluten, and indigo blue; and is particularly abundant in the families Cruciferae and Fungi. It enters into the composition of most animal substances, as albumen, fibrin, gelatin...
ucus, urea, uric acid, &c. It is found in the swimming bladders of fishes.

Preparation.—The readiest method of procuring nitrogen is to burn a piece of phosphorus in a confined portion of atmospheric air. The phosphorus combines with the oxygen of the air and forms metaphosphoric acid. The residual gas after being thoroughly washed is nearly pure nitrogen.

Properties.—It is a colourless, odourless, tasteless gas; neither combustible nor a supporter of combustion. It neither reddens litmus, nor whitens lime water. Its sp. gr. is 0·9722. It is very slightly absorbed by water. Its equivalent by weight is 14, by volume 1.

Characteristics.—Nitrogen is usually distinguished by its negative properties just described. The only positive test for it is combining it with oxygen to form nitric acid. This may be effected in two ways; either by electrifying a mixture of nitrogen and oxygen, or by burning in hydrogen in a mixture of oxygen and nitrogen. The nitric acid thus produced reddens litmus, and when absorbed by potash may be recognised by the tests hereafter to be mentioned. (See Nitric Acid.)

Physiological Effects.—The effects of nitrogen gas on vegetables and animals are analogous to those of hydrogen before mentioned (126). Thus, when inspired, it acts as an asphyxiating agent, by excluding oxygen; when injected into the blood it acts mechanically only. It is an essential constituent of the air employed in respiration.

Uses.—It has been mixed with atmospheric air, and inspired in certain pulmonary affections, with the view of diminishing the stimulant influence of the oxygen, and thereby of acting as a sedative. (Dict. Mat. Med.)

**Nitrogénii Protox'ydum.**—Protoxide of Nitrogen.

History and Synonyms.—This gas was discovered by Dr. Priestley in 1776. He termed it *dephlogisticated nitrous air*. Sir H. Davy, in "Researches" on it, calls it *nitrous oxide*. Its common name is *laughing gas*.

Natural History.—This compound is always an artificial production.

Preparation.—It is obtained by heating nitrate of ammonia in a glass retort. Every equivalent or 71 parts of the salt are resolved into 22 equivalents or 27 parts of water, and two equivalents or 44 parts of protoxide.

**Ingredients Used.**

<table>
<thead>
<tr>
<th>Product</th>
<th>Equivalent</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Nitr. 14</td>
<td>1 eq. Nitr. 14</td>
<td></td>
</tr>
<tr>
<td>Oxyg. 16</td>
<td>2 eq. Oxyg.</td>
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</tr>
<tr>
<td>Oxyg. 24</td>
<td>3 eq. Oxyg. 24</td>
<td></td>
</tr>
<tr>
<td>Nitr. 14</td>
<td>1 eq. Nitr. 14</td>
<td></td>
</tr>
<tr>
<td>Hydr. 3</td>
<td>3 eq. Hydr. 3</td>
<td></td>
</tr>
<tr>
<td>Water 27</td>
<td>3 eq. Water 27</td>
<td></td>
</tr>
</tbody>
</table>

Properties.—At ordinary temperatures and pressure it is a colourless gas, with a faint but disagreeable odour, and a sweetish taste. It is not combustible, but is a powerful supporter of combustion, almost rivalling this respect oxygen gas. Protoxide of nitrogen does not affect vegetable colours. It undergoes no change of colour or of volume when fixed with either oxygen or the binoxide of nitrogen.
Its equivalent, by weight, is 22, by volume 1. Its sp. gr. according to Dr. T. Thomson, is 1.5277. When subjected to a pressure of 50 atmospheres, at 45° F., it is condensed into a limpid colourless liquid.

**Characteristics.**—The only gas with which it is possible to confound it, is oxygen, with which it agrees in being colourless, not combustible, but a powerful supporter of combustion and re-inflaming a glowing match. It may be readily distinguished by mixing it with an equal volume of hydrogen, and exploding it by the electric spark, by which we obtain one volume of nitrogen and an equivalent or 9 parts of water.

**Composition.**—It consists of one equivalent or 14 parts of nitrogen and one equivalent or 8 parts of oxygen; or, by measure, a volume of nitrogen and half a volume of oxygen condensed into the space of a volume.

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<td>63·6</td>
<td>63·3</td>
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</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>36·4</td>
<td>63·7</td>
<td>Oxygen gas</td>
</tr>
</tbody>
</table>

**Protoxide Nitrogen** 1 | 22 | 100·0 | 10·0 | Protox. Nitrogen gas 1 | 1·527

**Physiological Effects.**

(a.) **On vegetables.**—Germinating seeds (peas when watered with a solution of this gas seemed unaffected by it. Plant introduced into vessels filled with the gas mostly faded in about three days, and died shortly after. (Davy's Researches.) But Drs. Turner and Christison did not find that it was injurious to vegetation. (Christison On Poisons, p. 756.)

(b.) **On animals.**—The effects of this gas on insects, annelides, mollusca, amphibia, birds, and mammals, were examined by Sir H. Davy. On all it acted as a positive poison. It produced "peculiar changes in the blood and in their organs, first connected with increased living action, but terminating in death." (Davy, p. 449.) Slowly injected into the veins of animals, considerable quantities were found by Nysten to produce slight staggering only; larger quantities produced the same disorder of the nervous system noticed when the gas is respired. (Recherches p. 77 and 78.)

(c.) **On man.**—When inhaled its effects on the nervous system are most remarkable: I have administered this gas to about one hundred persons and have observed that after the respiration of it from a bladder for a few seconds, it usually causes frequent and deep inspirations, blueness of the lips and countenance, an indisposition to part with the inhaling tube and a temporary delirium, which subsides in the course of three or four minutes. The sensations are usually pleasing. The delirium manifests itself differently in different individuals, as in some by dancing, in others by fighting, &c. In some few cases I have seen stupor produced. Singing in the ears, giddiness, and tingling sensations in the hands and feet are sometimes experienced.

**Uses.**—It has been employed in some few cases only of disease. Bees does use it in paralysis with benefit; but found it injurious to the hysterical and exquisitely sensible. (Davy's Researches, p. 542.) In a remarkable case of spasmodic asthma, related by Mr. Curtis (Lancet, vol. ii. 1828 and 1829), it acted beneficially. In a second case it also gave relief.
Acidum Nitricum.—Nitric Acid.

History and Synonymes.—This acid was known in the seventh century to Geber, who termed it solutive water, (Of the Invention of Verity, t. xxix and xxiii.) The nature of its constituents was shown by Cavendish in 1785, and their proportions were subsequently determined by Gay-Lussac, and Thomson. It has been known by various names, Glauber’s spirit of nitre, and aquafortis.

Natural History.—It is found in both kingdoms of nature.

(a) In the inorganic kingdom.—Combined with potash, soda, lime, magnesia, it is found on the surface of the earth in various parts of the world. The nitrates have been found in some few mineral waters. Thus there is a district of Hungary, between the Carpathians and the Drave, where all the springs, for the space of about 300 miles, contain a small quantity of the nitrate of potash (Gairdner, on Mineral Springs, p. 20).

(b) In the organic kingdom.—Nitrate of lime has been found in rago officinalis, Urtica dioica, Helianthus annuus, and Parietaria officinalis. Nitrate of potash has been detected in the roots of Cissampelos creiva, and Geum Urbanum; in the juice of Chelidonium majus; in Apium graveolens; and sometimes in the root of Beta vulgaris when advanced in age. The same salt is also found in the flowers of Verbascum, in the zome of Zingiber officinalis, in the fruit of Areca Catéchu, in the tubers of Cyperus esculentus, in Agaricus acris, and A. edulis (Decandolle, syiol. Végét. t. 1er, pp. 383, 387, and 403).

Preparation. (a) In the Pharmacopœia.—In the London Pharmacopœia we are directed to mix in a glass retort two pounds of dried nitrate of potash with an equal weight of strong liquid sulphuric acid, and to heat the nitric acid in a sand bath. Mr. Phillips (Translation of the Pharmacopœia) says that this process yields nitric acid of sp. gr. 1.5033.

The explanation of the changes which take place is somewhat modified by the strength of the sulphuric acid employed. According to Mr. Phillips, the acid usually met with has a sp. gr. of 1.8433: I have found generally somewhat below this. The acid alluded to by Mr. Phillips is composed, according to the same authority, very nearly of four equivalents or 160 parts of dry sulphuric acid, and five equivalents or 45 parts of water. These quantities re-act on two equivalents or 204 parts nitrate of potash, and produce two equivalents or 135 parts of strong acid nitric acid (sesquihydrate), and one equivalent or 274 parts of the hydrated bisulphate of potash.

Ingredients used. Products.

| Nitric Potash | 204 | 2 eq. Nitric Acid . 108 | 2 Sesquihydrate Nitric Acid 135 |
| Liq. Sulphuric Acid | 205 | 3 eq. Water . . . 27 | 2 Hydrated Sulphate Potash 274 |
| (Sp. gr. 1.8433) | | 2 eq. Water . . . 18 | |
| | | 4 eq. Sulphuric Acid 160 | |

instead of the glass retort directed in the Pharmacopœia, manufacturers usually employ an iron or stone ware pot, with a stone ware head, which is connected with a row of double necked stone ware bottles. (See fig. 41, p. 158).

(b) For commercial purposes.—The ordinary nitrous and nitric acids commerce arc prepared in an iron cylinder set in brickwork over a
fire-place (fig. 41). 168 lbs. of nitrate of potash are introduced at the end of the cylinder, which is afterwards closed by a circular disk of iron perforated to allow of the introduction of a leaden funnel, through which are poured 98 lbs. of strong sulphuric acid (sp. gr. 1.845). The funnel then removed, the aperture closed, and heat applied. The vapours conveyed into a row of five or six bottles of stone-ware filled to above one-sixth of their capacity with water. The acid obtained by this process is brown and fuming, and has a sp. gr. of 1.45. It is called in commerce nitrous acid, or fuming nitric acid. To render it colourless it is heated in a glass retort, placed in a sand bath: the vapour which escapes is passed through two stone-ware bottles to save any acid that may be expelled, and is subsequently conveyed into a chimney (fig. 42). The colourless acid remaining in the retort has a sp. gr. of about 1.44, and constitutes the nitric acid of commerce. The residue in the iron cylinder is a mixture of sulphate with a little bisulphate of potash, and is sold as sal enixum. It is employed as a flux, and by the alum-makers.

The quantity of the ingredients employed in the above process is nearly in the proportion of eight equivalents or 39 parts of strong sulphuric acid, and seven equivalents or 714 parts of nitrate of potash. Some manufacturers employ two parts by weight of nitrate of potash.

* For the above information I am indebted to Messrs. White, nitric acid manufacturers, Castle Street, Saffron Hill, London, who have kindly permitted me to make the above sketches of their apparatus.
one of strong sulphuric acid, or about an equivalent of each of the
dents. As the water of the sulphuric acid is not sufficient in quan-
to form liquid nitric acid with all the acid set free from the nitrate,
art of the nitric acid is decomposed into nitrous acid and oxygen. It
the presence of nitrous acid which communicates the red colour to the
merical or fuming nitric acid.
The generation of nitrous acid is greatest at the commencement and
wards the close of the operation: for at the commencement the excess
combined sulphuric acid attracts water from the small quantity of
cid then set free, in consequence of which the latter is resolved
litrous acid and oxygen: about the middle of the process, when the
ity of free nitric acid has increased while that of sulphuric acid has
ished, the former passes over with water, unchanged: but towards
end of the process, owing to the volatilization of the nitric acid, the
phric acid becomes again predominant, and the red vapours of nitrous
then make their appearance.
Properties.—Strong liquid nitric acid is colourless, and has a
ular odour, and an acid, intensely sour taste. In the air it evolves
fumes, formed by the union of the acid vapour with the aqueous
ur of the atmosphere; these fumes redden litmus, and become much
ater when mixed with the vapour of ammonia, owing to the formation
the nitrate of ammonia. The sp. gr. of the acid prepared according to
Pharmacopoeia is 1·5033 to 1·504, and Mr. Phillips believes this to
the strongest procurable; but Proust obtained it as high as 1·62,
wan 1·554, Davy 1·55, Gay-Lussac 1·510, Thenard 1·513. The acid
l in the shops as double aquafortis has a sp. gr. of 1·36. Single
fortis is of sp. gr. 1·22. It has a powerful affinity for water and, on
mixed with it, heat is evolved.
Nitric acid is easily deprived of part of its oxygen. Thus exposure to
ar light causes the evolution of oxygen and the production of nitrous
, which gives the liquid a yellow, orange, or reddish brown colour.
acid thus coloured may be rendered colourless by the appli-
dition of a gentle heat, to drive off the nitrous acid. Several of the
metallic combustibles rapidly decompose nitric acid, as charcoal,
sphorus, sugar, alcohol, volatile oils, resins, &c. The acid is unacted
by leaf gold, platinum, &c. Some of the metals also act powerfully
it, as copper (in the form of turnings) and tin (in the state of foil). A
le water added to the acid facilitates, in some cases, the action of me-
ton it. For an account of the anomalous relations of this acid and
must refer the reader to Becquerel's Traité de l'Electricité, tom. v.
3. The hydracids (as hydrochloric acid) decompose and are decom-
ed by nitric acid.
Characteristics.—Nitric acid is known by the following characters:
stains the cuticle yellow or orange; mixed with copper filings, effec-
tence takes place, owing to the escape of binoxide of nitrogen, and a
ish blue solution of nitrate of copper is obtained: the binoxide
us ruddy vapours in the air, by uniting with oxygen to form nitrous
gas; and passed into a solution of the protosulphate of iron, forms
ark olive-brown coloured liquid, which has a strong affinity for oxygen,
has in consequence been employed for analysing atmospheric air:
t the results obtained by it are uncertain. Morphia, brucia, or com-
ecial strychnia, communicates a red colour to nitric acid, which is
heightened by supersaturating with ammonia: powdered nux vomica renders this acid yellow or orange-coloured. If hydrochloric acid added to nitric acid, the mixture acquires the power of dissolving lead; the presence of gold in solution may be recognized by the protosulphate of iron, which strikes a purple or dark colour. Lastly, saturated with pure carbonate (or bicarbonate) of potash, a nitrate of potash procured.

The nitrates are known by the following characters:—they evolve oxygen when heated, and deflagrate when thrown on a red-hot cinder or charcoal; when heated with sulphuric acid they disengage nitric acid, which may be recognized by its action on morphia, brucia, commercial strychnia; lastly, when mixed with sulphuric acid and copper turnings, they generate binoxide of nitrogen, which is readily recognized by its blackening a solution of protosulphate of iron. This last-mentioned property enables us to recognize very minute portions of the nitrates. The mixture of the nitrate, copper filings, and sulphuric acid is to be put into the test-tube (fig. 43 a): adapt, by means of a cork, a small curved glass tube, containing at the bend (b) a drop or two of the solution of the protosulphate of iron; apply heat to the mixture in the test-tube, and in a few minutes the ferruginous solution becomes brown or blackish.

Composition.—Anhydrous or dry nitric acid, such as we find in some nitrates, has the following composition by weight:

|              | Eq. Wt. | Per Cent. | Lavoisier | Cavendish | Berzelius | Dar
|--------------|---------|-----------|-----------|-----------|-----------|-----------
| Nitrogen     | 1       | 14        | 25·9      | 20        | 25        | 26        | 29        |
| Oxygen       | 5       | 40        | 74·1      | 80        | 75        | 74        | 70        |
| Nitric Acid  | 6       | 54        | 100       | 100       | 100       | 100       | 100       |

Its composition by volume is, one volume of nitrogen gas and two and a half volumes of oxygen gas. The degree of condensation, however, is not known, as uncombined anhydrous nitric acid has not yet been procured.

Liquid nitric acid is composed of nitric acid and water. According to Mr. Phillips, when the specific gravity of the liquid is 1·5033 to 1·504, the composition is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry or Anhydrous Nitric Acid</td>
<td>1</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>Water</td>
<td>1½</td>
<td>13·5</td>
<td>2</td>
</tr>
</tbody>
</table>

100 grains of this acid will saturate about 217 grains of carbonat of soda.

The dilute nitric acid of the London Pharmacopoeia is prepared by mixing a fluid ounce of the strong liquid nitric acid with nine fluid ounces of distilled water. Its sp. gr. is 1·080. 100 grains saturat
NITRIC ACID.

out 31 grains of crystallized carbonate of soda. The following is its
imposition:

<table>
<thead>
<tr>
<th>11'44</th>
<th>14'3</th>
</tr>
</thead>
<tbody>
<tr>
<td>89'36</td>
<td>85'7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water</th>
<th>100'0</th>
</tr>
</thead>
</table>

IMPURITIES.—The presence of nitrous acid is known by the colour.
1 detect chlorine or the chlorides, dilute with distilled water, and apply
rate of silver; a white chloride of silver is precipitated. To recognise
phuric acid, add a solution of chloride of barium to the diluted acid;
ny insoluble white sulphate is thrown down. Any fixed impurities
y be obtained by evaporating the acid by heat.

PHYSIOLOGICAL EFFECTS.—(a.) On vegetables.—Nitric acid decomposes
different vegetable tissues to which it may be applied, and gives
em a yellow colour.

(b.) On animals.—Orfila found that 26 grains of commercial nitric acid
ected into the jugular vein, coagulated the blood, and caused death in
minutes (Toxicolog. Générale). Viborg threw a drachm of the acid,
ted with three drachms of water, into the jugular vein of two horses;
two hours they were well: the blood, when drawn, was slightly
ulated (Wibmer, die Wirkung, &c.) Introduced into the stomach of
gs it disorganizes this viscus, and causes death in a few hours.

(c.) On man.—On the dead body, M. Tartra has made various experi-
ents to determine the appearances produced by the action of nitric
id. Of course this caustic decomposes the organic textures; but the
omena presented vary according to different circumstances,— as the
antity employed, the presence of other substances, &c.

On the living body, its action of course varies, with the degree
centration or dilution of the acid. In the concentrated form the acid
es as a powerfully corrosive poison, which property it derives in part
n its affinity for water, but more especially from the facility with
ich it gives out oxygen; so that the appearances caused by its action
ome of the tissues are different from those produced by sulphuric
id. Thus the permanent yellow stain which it communicates to the
icle is peculiar to it. Iodine, indeed, stains the skin yellow or brown,
 little caustic potash readily removes the stain when recent; whereas
eweish yellow stain produced by nitric acid becomes orange on the addi-
on of an alkali or soap. Bromine also stains the skin yellow, but when
ently produced, the colour may also be removed by potash. The yellow
eton stain communicated to the lining membrane of the tongue,
arynx, &c. by nitric acid is well shewn in Dr. Roupell’s Illustrations of
Effects of Poisons. A preparation, presenting similar appearances, is
erved in the anatomical museum of the London Hospital. The
low substance produced by the action of nitric acid on fibrine, was
amed by MM. Fourcroy and Vauquelin the yellow acid: the same sub-
ance is probably produced by the application of nitric acid to other
imal principles. This yellow substance is bitter, and is said by
zelius to consist of yellow, altered fibrin, combined with nitric acid
id with malic acid, formed by the action of some nitric acid on the
rin. Nitric, like sulphuric acid, also chars the animal tissues, and
us, after the ingestion of it, the stomach is sometimes found blackened,
as if sulphuric acid had been swallowed. The symptoms are analogous
to those produced by sulphuric acid (see Sulphuric Acid). The yellow
bittern, or orange spots, sometimes observed on the lips, chin, or head,
will, when present, at once indicate the kind of acid swallowed. Some-
times the binoxide of nitrogen is evolved by the mouth.

Properly diluted, nitric acid produces effects similar to those of
other dilute acids (see pp. 81 and 84: also Hydrochloric and Sulphur
Acids). It is said, however, to act less evidently as a tonic, and to
more apt to disagree with the stomach, so that it cannot be employed
so long a period. In some cases it has excited ptyalism, and from the
circumstance, as well as from the occasional benefit derived from its use
the venereal disease, it has by some writers been compared, in its operation
to mercury; a comparison founded rather on theoretical than practical
considerations.

Uses.—(a.) Internal.—As nitric acid produces certain effects,
common with other mineral acids, it may be used as a substitute for
latter in various diseases. Thus, it is administered in conjunction with
the better infusions, in those conditions admitting of, or requiring, the use
of tonics. Properly diluted, it is employed as a refrigerant in febrile
disorders. In lithiasis, attended with phosphatic deposits in the urine,
it may be used instead of the sulphuric or hydrochloric acid. In some
obstinate cutaneous diseases, as impetigo, it is given to the extent of half
a drachm daily in barley water (Rayer, Treatise on the Diseases of the
Skin, p. 502). It may be employed also to relieve heartburn.

In 1793 this acid was used by Mr. Scott, a surgeon at Bombay, as
substitute for mercurial preparations, which Girtanner erroneously fancied
owed their efficacy to the quantity of oxygen which they contain.
Mr. Scott first tried it in chronic hepatitis, and with considerable suc-
cess. He then extended its use to venereal diseases, and obtained the
happiest results from it.

Subsequently, it has been most extensively employed in the last
mentioned diseases; but the success attending its use has been very
variable. That it has been, and is frequently serviceable, no one can
doubt who reads the immense body of evidence offered in its favour
by Scott, Kellie, Albers, Prioleau, Rollo, Cruickshank, Beddoes, Ferris
and others. But on the other hand it is equally certain that on very
many occasions it has been useless. The same remark, indeed, may
be made of mercury, or of any other remedy: but as an antivenereal medi-
cine it does not admit of comparison with this metal. However,
frequently meet with syphilitic cases in which the employment of
mercury is either useless or hurtful. Thus it can rarely be employ-
with advantage in scrofulous subjects; or in persons whose idiosyn-
crasies render them peculiarly susceptible to the influence of this metal
and in sloughing sores it is inadmissible. Now these are the cases
which nitric acid may be employed with benefit; and I believe the best
mode of administering it is in conjunction with the compound decoct of
sarsaparilla.

For further information respecting its employment, I must refer to
the works of Holst (De Acidis Nitrici usu Medico Dissertatio, Christian
1818) and Mr. Samuel Cooper (Dict. of Practical Surgery).

(b.) External.—In the concentrated state, nitric acid has been em-
ployed as a powerful caustic to destroy warts, and as an application
parts bitten by rabid animals or venomous serpents, to phagedenic ulcers, &c. In order to confine the acid to the spot intended to be acted on, the neighbouring parts may be previously smeared with some resinous ointment. In sloughing phagedena the application of strong nitric acid, recommended by Mr. Welbank (Medico-Chirurg. Trans. vol. xi.) is ended with the most successful results, as I have on several occasions witnessed. The best mode of applying it is by a piece of lint tied round a small stick or skewer. When the slough is very thick, it is sometimes necessary to remove part of it with a pair of scissors, in order to enable the acid to come in contact with the living surface.

Largely diluted (as 50 or 60 drops of the strong acid to a pint or quart water) it is recommended by Sir Astley Cooper as a wash for sloughing and other ill-conditioned sores.

In the form of ointment (Unguentum acidi nitrici, Ph. Dub.) it is used for various skin diseases, especially porrigo and scabies, and as an application to syphilitic sores.

Nitric acid vapour has been employed to destroy contagion, but it is probably inferior to chlorine. It was first introduced for this purpose by Carmichael Smyth (to whom Parliament granted a reward of £5000): since these fumigations have been termed Fumigationes nitricae Smythianae. The vapour is readily developed by pouring one part of oil of vitriol over 6 parts of nitrate of potash in a saucer placed on heated sand.

ADMINISTRATION.—Strong nitric acid may be administered, in some milder forms, in doses of from five to ten minims, three or four times daily. The milder nitric acid may be given to the extent of thirty or forty minims.

The Unguentum acidi nitrici, Ph. Dub., also called pomme de l'Athyon, or genized fat, is prepared by adding 5 1/2 fluidrachms of nitric acid to a measure of one pound of olive oil, and four ounces of prepared hog’s-lard. Oxide of nitrogen is evolved, showing that the nitric acid is decomposed. Part of the fatty matter is oxidized, and a portion is reverted into cladiine (see Unguentum hydrargyri nitritis). This ointment has a firm consistence and a yellow colour. It is more efficacious when recently prepared.

ANTIDOTES.—Poisoning by nitric acid requires precisely the same treatment as that by sulphuric acid. (See Sulphuric Acid).

Acidum Nitro-hydrochloricum.—Nitro-hydrochloric Acid.

HISTORY AND SYNONYMES.—This liquid was known to Geber (Invention Verity, ch. xxiii.). It was formerly called aqua regia, or nitro-muriatic acid. Its nature was first explained by Davy.

PREPARATION.—It is readily prepared, according to the Dublin Pharmacopoeia, by mixing 2 parts, by measure, of hydrochloric acid with 3 of nitric acid. In the arts, however, hydrochlorate of monia, or common salt, is often substituted for hydrochloric acid; or parts of potash for the nitric acid. By the re-action of one equivalent 34 parts of nitric acid on one equivalent or 37 parts of hydrochloric acid, we obtain one equivalent or 46 parts of nitrous acid, one equivalent 46 parts of chloride, and an equivalent or 9 parts of water.

INGREDIENTS USED. RESULTS.

<table>
<thead>
<tr>
<th>Hydrochloric Acid 37</th>
<th>1 eq. Chlorine . 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Hydrogen 12</td>
<td>1 eq. Water . 9</td>
</tr>
<tr>
<td>Nitric Acid 54</td>
<td>1 eq. Nitric Acid 46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 eq. Chlorine . 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Nitric Acid 46</td>
</tr>
</tbody>
</table>
Properties.—It has a yellow colour. Its most remarkable property is that of dissolving gold and platinum, metals that are insoluble in either nitric or hydrochloric acid separately. It should be kept in a cool, dark place; for heat rapidly expels the chlorine, while light enables it to decompose the water and to form hydrochloric acid.

Characteristics.—It is recognised by its colour, by its power of dissolving gold, by its precipitating a solution of nitrate of silver; the precipitate being insoluble in nitric acid, but soluble in ammonia; by the production of two salts, a chloride and a nitrate, when an alkali is added to it; and by the evolution of binoxide of nitrogen on the addition of copper turnings (see Nitric Acid).

Physiological Effects.—It is a powerfully corrosive poison, acting in a similar manner to nitric acid.

Uses.—It has been employed internally in the same cases as nitric acid, more especially syphilis, diseases of the liver, and some of the exanthemata. Externally it has been used as a bath, either local or general, in syphilis and hepatic affections. In India the whole body (the head excepted) is immersed, but in this country pediluvia only is usually employed, or the body is merely sponged with it. The nitric muriatic bath is prepared in wooden tubs, by adding this acid to water until the latter becomes as acid to the taste as vinegar (from $4\frac{1}{2}$ to 6 fluid ounces of the acid to about 3 gallons of water in a deep narrow tub). The patient should remain in the bath from 10 to 30 or 40 minutes. It excites tingling and prickling of the skin, and is said to affect the gum and salivary glands, causing plentiful ptyalism; indeed, we are told that without the latter effect, every trial is to be regarded as inconclusive. In the passage of biliary calculi this bath is said to be remarkably effective.

Administration.—When taken internally the dose is three or five drops properly diluted and carefully increased.

Antidote.—Poisoning by this acid is to be treated in the same way as that by sulphuric acid.

Ammonia.—Ammo’nia or Ammon’iacal Gas.

History and Synonyms.—Dr. Black, in 1756, first pointed out the distinction between ammonia and its carbonate; and Dr. Prestley (On Air, vol. ii. p. 369, 1790) first procured ammonia in a gaseous form. It is called it alkaline air. It is sometimes termed volatile alkali, and occasionally azoxygened hydrogen.

Natural History.—Ammonia, free or combined, exists in both kingdoms of nature.

(a) In the inorganized kingdom.—Hydrochlorate and sulphate ammonia are met with native usually in the neighbourhood of volcanoes. Aluminous sulphate of ammonia (or ammonia-alum) occurs in Bohemia. Dr. Marcet detected the hydrochlorate in sea water. This salt has been recognized in mineral waters (Gairdner, On Mineral Springs, p. 185). Ammonia exists in many of the native oxides of iron, and in some chalk waters (Dict. des Drogues, t. i. p. 293).

(b) In the organized kingdom.—Ammonia is found in vegetables, small quantities only. In the free state, it is said to exist in seven plants, as Chenopodium vulvaria, Sorbus aucuparia (Dict. des Drog...
Afterwards.

and artificial)

By 37 carbonic in 1 volume not slightly 8 eq. ec half Calcium violet, 17 obtained a (in spheres, the 117 spontaneous 117. Nymphcea; in the leaves of Aconitum Napellus; in the barks of Cusparia brifuga and Simaruba; and in the fruit of Areca Catechu (Decandolle, Physiol. Végét. p. 339). Lastly, it is developed during the decompo-

sition (spontaneous or artificial) of most vegetable substances which contain nitrogen, as gluten.

Ammonia is one of the bases found in the urine of man, where it exists in combination with phosphoric, hydrochloric, and uric acids. United the last-mentioned acid, it exists in the excrement of the boa constrictor, and of some birds. The hydrochlorate is found in the dung of the camel. Ammonia is one of the products of the putrefaction of animal matters.

Preparation.—Ammoniacal gas is obtained by heating a mixture of hydrochlorate of ammonia and quicklime in a glass retort, and collecting over mercury. In the absence of a mercurial apparatus, the gas may be generated in a Florence flask, to the mouth of which a straight glass tube connected by means of a cork. The bottles which are to be filled with gas are to be inverted over the tube.

In this process, one equivalent or 54 parts of hydrochlorate of ammonia are decomposed by one equivalent or 28 parts of lime; and the results of the decomposition are one equivalent or 17 parts of ammonia; one equivalent or 56 parts of chloride of calcium, and one equivalent or parts of water.

INGREDIENTS USED.

<table>
<thead>
<tr>
<th>q. Hydrochl. &amp;c.</th>
<th>1 eq. Ammonia</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amm.</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>eq. Lime</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>eq. Oxygen</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>eq. Calcium</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

RESULTS.

<table>
<thead>
<tr>
<th>eq. Ammonia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlor. 36</td>
<td></td>
</tr>
<tr>
<td>Hydr. 12</td>
<td></td>
</tr>
<tr>
<td>Water 9</td>
<td></td>
</tr>
<tr>
<td>Chl. Calcium</td>
<td>56</td>
</tr>
</tbody>
</table>

Properties.—It is a colourless invisible gas, having a strong and all-known odour. It reddens turmeric paper, and changes the colour of violet juice to green; but by exposure to the air, or by the application of heat, both the turmeric paper and violet juice are restored to their original colour. The sp. gr. of this gas is 0.59. By a pressure of 6.5 atmospheres, at the temperature of 50°, it is condensed into a colourless, transparent liquid. Ammoniacal gas is not a supporter of combustion, but is slightly combustible in the atmosphere, and when mixed with air or oxygen it forms an explosive mixture. Every two volumes of ammoniacal gas require one and a half volumes of oxygen for their complete combustion. The results of the explosion are, a volume of nitrogen and some water.

Characteristics.—It is readily recognised by its peculiar odour, its action on turmeric paper, and by its forming white fumes with hydrochloric acid or chlorine. Dissolved in water, it communicates a deep blue colour to the salts of copper, and throws down a yellow precipitate (platino-bichloride of ammonia) with the chloride of platinum.
Conia agrees with ammonia in evolving a vapour which reddens turmeric paper, and forms white fumes (hydrochlorate of conia) with hydrochloric acid gas.

Composition.—Ammonia is composed of hydrogen and nitrogen, the following proportions:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>1</td>
<td>14</td>
<td>82·35</td>
<td>81·13</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>3</td>
<td>3</td>
<td>17·65</td>
<td>18·87</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>17</td>
<td>100·00</td>
<td>100·00</td>
</tr>
</tbody>
</table>

Constituents.

\[
\begin{array}{cc}
1 \text{ eq. Nitr.} & 1 \text{ eq. Hydr.} \\
= 14 & = 1
\end{array}
\]

\[
\begin{array}{cc}
1 \text{ eq. Hydr.} & 1 \text{ eq. Hydr.} \\
= 1 & = 1
\end{array}
\]

\[
\text{Eq. Vol.} = \frac{1 \text{ eq. Amm.}}{17}
\]

The annexed diagram illustrates the volumes of the constituents of the gas, and their degree of condensation when in combination to form ammoniacal gas.

Physiological Effects.—(a.) On vegetables.—Ammoniacal gas is destructive to plants, and changes their green colour to brown (Decandolle, Physiol. Vég., p. 1344).

(b.) On animals.—If an animal be immersed in this gas, spasm of the glottis is immediately brought on, and death results from asphyxia. Nysten (Recherches, p. 140) injected some of this gas into the veins of a dog: the animal cried out, respiration became difficult, and death soon took place. Neither gas nor visible lesion was observed in the heart, the two ventricles of which contained liquid blood. In another experiment he threw ammoniacal gas into the pleura of a dog: cries, evacuation of urine, and vomiting, immediately followed; soon afterwards convulsions came on, and continued for several hours; ultimately they ceased and recovery took place.

In almost all cases of poisoning in animals, by ammonia, or its carbonate, convulsions are observed, apparently shewing that these substances act on the spinal marrow.

(c.) On man.—Ammonia is a powerful local irritant. This is proved by its pungent odour, and its acrid and hot taste; by its irritating the eyes; and, when applied for a sufficient length of time to the skin, by its causing vesication. If an attempt be made to inhale it in the pure form, spasm of the glottis comes on: when diluted with atmospheric air, it irritates the bronchial tubes and larynx, and, unless the quantity be very small, brings on inflammation of the lining membrane. Its powerful action on the nervous system is best seen in cases of syncope (see Aqu. Ammoniæ).

Uses.—Ammoniacal gas is rarely employed in medicine. M. Bourguignon de Béziers used it with success in the case of a child affected with cropp, to provoke the expulsion of the false membrane.

Antidote.—In case of the accidental inhalation of strong ammoniacal vapour, the patient should immediately inspire the vapour of acetic or hydrochloric acid. If bronchial inflammation supervene, of course it is to be treated in the usual way.

A'qua Ammoniæ. — Water of Ammoniæ.

History and Synonymes.—The Liquor ammoniæ of the London Pharmacopæia is, more properly as 1 conceive, denominated aqua ammoniæ.
the United States and Edinburgh Pharmacopoeias. In the Dublin Pharmacopoeia it is called *aqua ammonia caustica*. It has also been termed *spiritus satis ammoniaci causticus, cum calce vivae paratus*.

**Preparation.—** (a.) In the London Pharmacopoeia it is prepared from one ounce of hydrochlorate of ammonia, eight ounces of lime, and two parts of water. The lime, slacked with water, is to be first put into a cist, and then the hydrochlorate of ammonia broken into small pieces: the remainder of the water is then to be added, and fifteen fluid ounces the solution of ammonia distilled.

The theory of the process is the same as that for making ammoniacal gas as described. The equivalent proportions of hydrochlorate of ammonia and lime are 54 of the first and 28 of the latter. Now it is obvious that four lime is employed in the process of the London Pharmacopoeia than is theoretically necessary, if the ingredients were pure. Yet in some other Pharmacopoeias the quantity is considerably greater. Thus in that of Dublin the proportions are three parts of hydrochlorate, two parts of lime, and ten parts of water. In the Edinburgh and United States Pharmacopoeias the quantities are, a pound of hydrochlorate, a pound and a half of lime, pint (or pound) of distilled water, and nine ounces of distilled water. The distilled water is placed in the receiver to absorb the gas. The advantage contended for by using this great excess of lime is the facility with which the ammonia is disengaged: but this is more than compensated in the Edinburgh and United States processes by the inconvenient bulk of the ingredients. Some excess is of course necessary to allow for impurities.

(b.) In commerce, the impure sulphate of ammonia is frequently substituted for the hydrochlorate. The apparatus employed is an iron cylinder connected with the ordinary worm refrigerator, and this with a row of bottle-necked stone-ware bottles containing water, analogous to those described under the head of nitric acid (see *Nitric Acid*).

**Properties.—** Solution of ammonia is a colourless liquid, having a very pungent odour, and a caustic alkaline taste. Its action on turmeric paper and violet juice is like that of ammoniacal gas before described, is lighter than water, but its sp. gr. varies with its strength. In the cops a very strong solution (called *Liquor ammonia fortior*) is kept, having sp. gr. 0'880: it is employed for smelling-bottles. Prepared according to the London Pharmacopoeia, the sp. gr. of the water of ammonia is 0'960; according to the Dublin, 0'905; according to the United States, 0'944; and according to the Edinburgh, 0'939. The quantity of ammoniacal gas which water can dissolve varies with the pressure of the atmosphere and the temperature of the water.

Davy (Elements of Chem. Phil. p. 268) ascertained that at the temperature of 50°, under a pressure equal to 29'8 inches, water absorbs about 100 times its volume of gas, and becomes of sp. gr. 0'875. He drew up the following table, shewing the quantity of ammonia in solutions of different specific gravities:—

<table>
<thead>
<tr>
<th>0 parts of Sp. Gr.</th>
<th>Of Ammonia</th>
<th>100 parts of Sp. Gr.</th>
<th>Of Ammonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'8750</td>
<td>contain</td>
<td>0'9433</td>
<td>contain</td>
</tr>
<tr>
<td>0'8875</td>
<td>32'50</td>
<td>0'9476</td>
<td>14'53</td>
</tr>
<tr>
<td>0'9000</td>
<td>29'25</td>
<td>0'9513</td>
<td>13'46</td>
</tr>
<tr>
<td>0'9054</td>
<td>26'00</td>
<td>0'9545</td>
<td>12'40</td>
</tr>
<tr>
<td>0'9106</td>
<td>23'37</td>
<td>0'9573</td>
<td>11'56</td>
</tr>
<tr>
<td>0'9235</td>
<td>22'07</td>
<td>0'9597</td>
<td>10'82</td>
</tr>
<tr>
<td>0'9326</td>
<td>19'54</td>
<td>0'9619</td>
<td>10'17</td>
</tr>
<tr>
<td>0'9385</td>
<td>17'52</td>
<td>0'9622</td>
<td>9'60</td>
</tr>
<tr>
<td>0'9588</td>
<td>15'88</td>
<td>0'9692</td>
<td>9'50</td>
</tr>
</tbody>
</table>
It appears from the observations of Davy and Dalton that the specific gravity of mixtures of liquid ammonia and water is exactly the mean of the two ingredients.

**Composition.**—From the above observations the composition of official solutions of ammonia is nearly as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammoniacal gas</td>
<td>10</td>
<td>12·5</td>
<td>14·5</td>
<td>15·8</td>
<td>15·8</td>
</tr>
<tr>
<td>Water</td>
<td>90</td>
<td>87·5</td>
<td>85·5</td>
<td>84·2</td>
<td>82·0</td>
</tr>
</tbody>
</table>

**Characteristics.**—(See *Ammoniacal Gas*).

**Impurities.**—Liquor ammonia frequently contains traces of the carbonate of ammonia which may be detected by lime-water, or by a solution of the chloride of calcium, either of which occasions a white precipitate of the carbonate of lime. When a portion of the liquid has been neutralized by pure nitric acid, it ought not to cause a precipitate by the addition of the nitrate of silver, of oxalic acid, or of sesquicarbonate of ammonia: for the first would indicate the presence of hydrochloric acid or chloric; the second, of lime; the third of lime, or other earthy matters.

**Incompatibles.**—It is hardly necessary to say that all acids are incompatible with ammonia. With the exception of the salts of potash, soda, lithia, lime, baryta, and strontia, ammonia decomposes most of the metallic salts.

**Physiological Effects.**—(a.) *On vegetables.* The effects of ammonia on plants have been before noticed.

(b.) *On animals.* Orfila injected sixty grains of liquor ammonia into the jugular vein of a strong dog: tetanic stiffness immediately came on the urine passed involuntarily, and the animal became agitated by convulsions: death took place in ten minutes. The body was immediately opened, when the contractile power of the muscles was found extinct. In another experiment, thirty-six grains of concentrated solution of ammonia were introduced into the stomach, and the oesophagus tied: in five minutes the animal appeared insensible, but in a few moments after was able to walk when placed on his feet; the inspiration were deep, and his posterior extremities trembled. In twenty hours he was insensible, and in twenty-three hours died. On dissection the mucus membrane of the stomach was found red in some places. These experiments show the effects of large doses of this solution on the nervous system. The first experiment agrees in its results (that is, in causing tetanic convulsions) with that made by Nysten, and which has been before mentioned, of throwing ammoniacal gas into the cavity of the pleura. From the convulsions it may be inferred that in these instances the (grey matter of the) spinal marrow was specifically affected.

(c.) *On man.* a. *Local effects.*—In the concentrated form the local action of liquor ammonia is exceedingly energetic. Applied to the skin it causes pain, redness, vesication, and destruction of the part; the acting first as a rubefacient, then as a vesicant, and lastly as a caustic o corrosive. Its emanations are also irritant: when they come in contact with the conjunctival membrane, a flow of tears is the result; when inhaled, their powerful action on the air-passage is well known. Persons in syncope are observed to be almost immediately raised from a
AQUA AMMONIA.

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Path-like state, merely by inhaling the vapour of this solution. In cases of insensibility it must be employed with great caution; for, if used judiciously, serious or even fatal consequences may result. Nysten (Christison's Treatise) tells us that a physician, for some years subject to epilepsy, was found by his servant in a fit. In order to rouse his master, the latter applied a handkerchief moistened with this solution to his nose, so assiduously, that he brought on bronchitis, of which the physician died on the third day. In the Edinburgh Medical and Surgical Journal, there is the report of the case of a lad whose death as produced, or at least hastened, by an attendant applying, "with such wearied but destructive benevolence," ammonia to the nose, that suffocation had almost resulted. Dyspnœa, with severe pain in the throat, immediately succeeded, and death took place forty-eight hours afterwards. A French physician also suffered ulceration of the mouth, and plent pulmonary catarrh, in consequence of the excessive use of ammonia, given as an antidote for hydrocyanic acid.

When the solution of ammonia is swallowed in large doses, it acts as powerfully corrosive poison; but modern well-marked cases in the human subject are wanting. However, it is very evident that violent inflammation of all that part of the alimentary canal with which the poison may be in contact, would be the result, and that if much be taken, decomposition of the part might be expected. When swallowed in a very dilute form, and in small quantity, the local phenomena are not very marked, and the effect of the substance is then seen in the affection of the general system. The chemical action of ammonia on the tissues is analogous to that of staph, hereafter to be described.

β. Remote effects.—The remote effects may be investigated under two ads, according as they are produced by small or large doses. In small therapeutic doses, such as we are accustomed to employ in the treatment of diseases, ammonia acts as a stimulant, excitant, or calefacient, produces a sensation of warmth in the mouth, throat, and epigastrium, frequently attended with eructations. The pulse is soon rendered quicker and fuller; the heat of the skin is sometimes increased, and there is a ten- dency to sweating, which, if promoted by the use of warm diluents and bathing, frequently terminates in copious perspiration. But the skin is not the only secreting organ stimulated to increased exertion; we observe the kidneys produce more urine, and frequently the quantity of bronchial mucus is increased. The nervous system is also affected. Wibmer (Ie Wirkung, &c. p. 123) has made several experiments on himself, and on them it appears that ammonia affects the head, sometimes causing oppression, or a sense of fulness, but no pain. The increased capacity of muscular exertion, the excitement of the mental functions, and the greater facility with which all the functions are executed, are further indications of the action of ammonia on the nervous system. The effects of large or poisonous doses on the human subject have not been described: but that the nervous system is affected, seems probable from a case mentioned by Plenck, which terminated fatally in four minutes; though the symptoms are not related.

The modus operandi of ammonia deserves to be noticed. Does this substance become absorbed? I am not acquainted with any facts which are able to decide this question. Even admitting that absorption does take place, it is more likely that the remote effects are of a sympathetic
kind, than the result of the absorption. In calculous complaints, ammonia and its carbonate may be used with considerable advantage in those cases where potash and soda are serviceable; from which I think it probable that, like the fixed alkalies, ammonia taken into the stomach is evolved by the kidneys.

Uses.—We resort to a solution of ammonia, properly diluted, on a variety of occasions, some only of which can be here noticed.

1. To neutralize acid.—In dyspeptic complaints, accompanied with preternatural acidity of stomach and flatulence, but without inflammation, a properly diluted solution of ammonia may be employed with a two-fold object—that of neutralizing the free acid, and of stimulating the stomach. It must be remembered that the healthy secretions of the stomach are of an acid nature, and that the continued use of ammonia, or any other alkali, must ultimately be attended with injurious results, more especially to the digestive functions. While, therefore, the occasional employment of alkalies may be serviceable, their constant or long-continued use must ultimately be deleterious.

Ammonia may, under some circumstances, be employed to neutralize acids introduced into the stomach from without, as in poisoning by the mineral acids, though chalk and magnesia would be more appropriate being less irritant. It is a valuable antidote in poisoning by hydrocyanic acid. Its beneficial operation has been ascribed to the union of the alkali with the acid, thereby forming the hydrocyanate of ammonia, but since it has been found that this salt is highly poisonous, it is evident that this explanation is not satisfactory. Some have ascribed the activity of the hydrocyanate to its decomposition by the free acids of the stomach, and the consequent evolution of free hydrocyanic acid, but the explanation is unsatisfactory. I believe the efficiency of ammonia as an antidote to poisoning by hydrocyanic acid, arises from its exerting an influence of an opposite nature to that of the poison. In poisoning by the oil of bitter almonds, or other agents supposed to contain this acid, ammonia is equally serviceable. The remedy should be given by the stomach, if the patient can swallow, and the vapour should be cautiously inhaled.

2. To produce local irritation, rubefaction, vesication, or destruction of the part.—As a local agent, ammonia has been employed in a variety of diseases, sometimes as a rubefacient or irritant, sometimes as a vesicant and occasionally as a caustic. Thus it is employed as a rubefacient in rheumatic and neuralgic pains, and as a counter-irritant to relieve internal inflammations. As a local irritant, a weak solution has been injected into the vagina and uterine, to excite the catamenial discharge; but there are some objections to its use. Thus, it is a most unpleasant kind of remedy, especially to young females; moreover, the stoppage of this discharge is in many cases dependent on constitutional or remote causes and, therefore, a topical remedy is not likely to be beneficial. Lavage employed ten or fifteen drops of the solution diluted with milk. The following is Nisato's formula:


Sometimes ammonia is employed as a vesicatory; and it has two advantages over cantharides—a more speedy operation, and non-affection of the urinary organs. It may be employed in the form of ointment or
3. The vapour of the solution of ammonia may be inhaled when we wish to make a powerful impression on the nervous system, as in syncope, or to prevent an attack of epilepsy. To guard against or relieve a paroxysm, ammoniacal inhalations are very powerful and useful; their application is frequently astonishing. Pinel says he once relieved an attack of epilepsy prevented by this means. The patient (a patchmaker) had intimations of the approaching paroxysm from certain signs, but he found by inhaling the vapour of ammonia it was frequently prevented. In the case of a confirmed epilepsy, which I was in the habit of watching for some years, I think I have also seen analogous beneficial effects. I speak doubtfully, because it is so difficult to determine, in most cases, the actual approach of the fit. It is deserving of special notice that ammonia is useful in three conditions of system, rich, though produced by very different causes, present analogous symptoms; viz., idiopathic epilepsy—the insensibility and convulsions (epilepsy) produced by loss of blood—and the insensibility and convulsions (? epilepsy) which poisonous doses of hydrocyanic acid give rise to. In asphyxia, ammoniacal inhalations have been strongly recommended by Sage, who says that he produced the apparent death of rabbits by immersion in water, and recovered them subsequently by the use of ammonia. A case is told of a man who had been submerged in the sea for twenty minutes, and who, when taken out of the water, appeared dead, yet by the use of ammonia recovered; and a M. Routier, a surgeon of Amiens, is said to have restored a patient in the same way, that it may sometimes be of service I can readily believe, but it must be employed with great caution.

4. Ammonia is given internally as a stimulant and sudorific in a variety of cases with manifest advantage. In recapitulating these, I must be very brief.

(a.) In continued fevers which have existed for some time, and where violent action has subsided, and the brain does not appear much disturbed, ammonia is occasionally of great service. Its diaphoretic action could be promoted by diluents and warm clothing. It has an advantage over opium—that if it does no good, it is less likely to do harm.

(b.) In intermittent fevers, ammonia is sometimes of advantage given in the cold stage to hasten its subsidence.

(c.) In the exanthemata, when the eruption has receded from the skin, and the extremities are cold, ammonia is sometimes of great benefit on account of its stimulant and diaphoretic properties. But in many of these cases the recession arises from, or is connected with, an inflammatory condition of the bronchial membrane, for which the usual treatment to be adopted.

(d.) In some inflammatory diseases (especially pneumonia and rheumatism) where the violence of the vascular action has been reduced by proper evacuations, and where the habit of the patient is unfavourable to a loss of blood, ammonia has been serviceable.

5. In certain affections of the nervous system, ammonia is frequently employed with the greatest benefit. Thus it has been used to relieve a cerebral disorder of intoxication. In poisoning by those cerebrospinal fluids commonly termed sedatives, such as foxglove, tobacco, and...
hydrocyanic acid, ammonia is a most valuable agent. This remedy has been supposed to possess a specific influence in relieving those disorders of the nervous system accompanied with spasmodic or convulsive symptoms; and hence it is classed among the remedies denominated *antispasmodic*: but whenever it gives relief it is by its stimulant operation. Velsen, of Cleves, has used it with advantage in delirium tremens. It was a remedy frequently tried in the malignant or Indian cholera, an occasionally procured relief, but this effect was not sufficiently common to lead practitioners to place much reliance on it.

6. Against the bites of poisonous animals, as serpents and insect, ammonia is frequently employed with the best effects. There does not appear, however, any ground for the assertion of Sage, that it is a specific: in fact, Fontana declares it to be sometimes hurtful in viper bites.

**Administration.**—It is given in doses of from five to twenty or thirty drops properly diluted.

**Antidotes.**—The dilute acids, as vinegar, lemon or orange juice, &c.

**Car'bonas Ammon'iae.**—Car'bonate of Ammon'ia.

**History and Synonymes.**—Raymond Lully, in the thirteenth century, was acquainted with carbonate of ammonia as obtained from urine; and it is probable that the Arabians had known it long before. Bas Valentine procured it by decomposing muriate of ammonia by potash (carbonate of potash).

Carbonate of ammonia has been known by the various appellations of *sal alkali volatile siccum seu urinosum; sal volatile salis ammoniaci; sal carbonas ammoniae; sal volatile cornu cervi,* &c.

**Natural History.**—(See Ammonia.) Carbonate of ammonia is formed during the putrefaction or destructive distillation of those organic substances which contain nitrogen.

**Preparation, Properties, Effects, and Uses.**—In the pharmacy this salt is extracted from hydrochlorate of ammonia by carbon of potash. The proportions employed in making the *spiritus ammonii spiritus ammonie aromaticus,* and *spiritus ammonie fielidis,* are twenty-one ounces of the hydrochlorate and sixteen ounces of the carbonate. On equivalent or 54 parts of the hydrochlorate of ammonia react on one equivalent or 70 parts of carbonate of potash, and produce one equivalent or 39 parts of the carbonate of ammonia, one equivalent or 76 parts chloride of potassium, and one equivalent or 9 parts of water.

**Ingredients Used.**

<table>
<thead>
<tr>
<th>Ingredients Used</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Hydrochlo, Ammonia .54</td>
<td>1 eq. Carb, Amm.</td>
</tr>
<tr>
<td>1 eq. Hydrochlo, 1 eq. Hydr. Acid 37</td>
<td>1 eq. Water .</td>
</tr>
<tr>
<td>1 eq. Carbonic Acid .22</td>
<td></td>
</tr>
<tr>
<td>1 eq. Potash 48 1 eq. Oxyg. 8</td>
<td></td>
</tr>
<tr>
<td>1 eq. Potas, 40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 eq. Chi, Potas.</td>
</tr>
</tbody>
</table>

**1. Spiritus Ammonie (Ph. L.)**—This compound is prepared from one ounce of hydrochlorate of ammonia, sixteen ounces of carbonate of potash, three pints of rectified spirit, and three pints of water. This mixture is placed in a retort, and three pints distilled. The above-described decomposition takes place, and the carbonate of ammonia, which is produced, distils over with the spirit in which the greater part of it dissolves, the remainder being deposited in an imperfectly crystalline state.
A Dublin Pharmacopoeia, a similar compound is prepared by mixing three ounces and a half of coarsely-powdered sesquicarbonate of ammonia with three pints of heated rectified spirit; by the disengagement of the carbonic acid, carbonate of ammonia is produced, which dissolves the spirit, every fluid ounce of which is capable of taking up thirty grains of the carbonate.

The *spiritus ammoniac* of either of the above pharmacopoeias is a transparent, colourless liquid, having a pungent smell and acrid taste. It dells turmeric paper, and dissolves camphor and the volatile oils. Its medicinal effects and uses are analogous to caustic ammonia and the sesquicarbonate. It is less pungent than the solution of caustic ammonia, but more so than the liquor ammoniac sesquicarbonatis. It is employed in hysteria, flatulent colic, and nervous debility, in doses of from half a drachm to a drachm, properly diluted with water. Saturated with camphor it forms a highly stimulating liniment.

2. *Spiritus ammoniac aromaticus* (Ph. L.).—This compound, usually termed *spirit of salt volatile*, is very analogous to the last, from which it differs in the somewhat different proportions of the ingredients, and the addition of some aromatics. It is prepared from five ounces of hydrochlorate of ammonia, eight ounces of carbonate of potash, two drachms of bruised cinnamon, two drachms of bruised cloves, four ounces of mon-peel, four pints of rectified spirit, and four pints of water. Mix, and let six pints distil. In this process, double decomposition takes place, already noticed, and the carbonate of ammonia distils over with the spirit and part of the water, flavoured by the aromatics. This preparation is weaker than the preceding, but is more agreeable both to the taste and smell. Its effects, uses, and doses, are analogous to those of the last-mentioned compound. It is an ingredient in the ammoniated tincture of guaiacum and the compound tincture of valerian.

3. *Spiritus ammoniac foetidus* (Ph. L.).—This is prepared in the same way as the spiritus ammoniac, except that five ounces of asafetida are put into the retort with the other ingredients. It is prepared in the Dublin Pharmacopoeia by digesting one ounce and a quarter of asafetida, two pints of spirit of ammonia, and distilling one pint and a half. This foetid spirit of ammonia has been very correctly declared to be useless. It is merely a solution of the volatile oil of asafetida in spirit of ammonia, or which a mixture of the tincture of asafetida and spirit of ammonia may be conveniently substituted. It is colourless, pungent, and fastid, and by age becomes brownish. It is employed in hysteria in doses of half a drachm to a drachm in water.

**Ammon'nia Sesquicarbonas.---Sesquicarbonat of Ammon'niu.**

**History and Synonyms.**—Though this salt must have been long known, yet, until a few years since, it was confounded with the carbonate of ammonia. It is even now frequently called carbonate or subcarbonate of ammonia in the shops. It is sometimes termed volatile or smelling salts; and occasionally bakers' salt, on account of its use by bakers in the manufacture of some of the finer kinds of bread.

**Natural History.**—(See Ammonia and Ammonia Carbonas.)

**Preparation.**—In the London Pharmacopoeia we are ordered to mix pound of powdered hydrochlorate of ammonia with a pound and a
half of powdered chalk, and sublime with a gradually increased heat. In this process three equivalents or 162 parts of hydrochlorate of ammonia react on three equivalents or 150 parts of carbonate of lime, and produce two equivalents or 118 parts of the hydrated sesquicarbonate of ammonia, three equivalents or 168 parts of chloride of calcium, or equivalent or 17 parts of ammonia, and one equivalent or 9 parts of water. The chloride of calcium is left in the subliming pot, the hydrated sesquicarbonate is sublimed, while the ammonia and water are dissipated.

INGREDIENTS USED.

RESULTS.

| 3 eq. Mur. | 3 eq. Mur. Amm. 111 | 3 eq. Hydr. 3 | 3 eq. Water, 9 | 1 eq. Water 9 |
| 2 eq. Amm. 10 | 3 eq. Chlor. 105 | 1 eq. Water, 18 | 1 eq. Amm. 17 |
| 3 eq. Carb. 60 | 3 eq. Carb. Acid 60 | | | |
| 3 eq. Lime, 84 | 3 eq. Lime, 84 | | | | |
| 3 eq. Calc. 60 | 3 eq. Hyd. Sesquic. Amm. 11 | | | |
| 3 eq. Chloride Calcium 18 |

Sesquicarbonate of ammonia is generally procured on the large scale by subliming the ingredients in an iron pot, to which an earthen or leaden head is adapted as a receiver. As a substitute for hydrochlorate of ammonia, manufacturers frequently employ impure sulphate of ammonia; but the resulting sesquicarbonate is sometimes contaminated with a little tar or oil, and deposits a dark carbonaceous matter when dissolved in acids.

PROPERTIES.—Sesquicarbonate of ammonia is met with in the form of fibrous, white, translucent cakes, about two inches thick. When exposed to the air it evolves carbonate of ammonia, and is converted into bicarbonate of ammonia; so that its vapour has a pungent odour, and strongly reddens turmeric paper. The resulting hydrated bicarbonate is opaque, pulvcrnt, and much less pungent, from which it has been termed mild carbonate of ammonia. The sesquicarbonate is soluble in four times its weight of cold water; but boiling water or alcohol decomposes it, dissolving the carbonate of ammonia, and evolving carbonic acid.

The liquor ammoniae sesquicarbonatis (Ph. L.) is prepared by dissolving four ounces of this salt in a pint of water.

CHARACTERISTICS.—This is recognized as an ammoniacal salt by its odour, its fugacious action on turmeric paper, and by the action of its solution on the salts of copper and on the chloride of platinum (sec. Ammonia). From a solution of caustic ammonia it may be distinguished by the white precipitate which it produces with the calcareous salts. From the monocarbonate this salt is distinguished by the effervescence caused when it is put into boiling water or alcohol. From the bicarbonate it may be known by its greater pungency and solubility.

COMPOSITION.—This salt consists, according to Mr. Phillips (Quarterly Journal of Science, vol. vii. p. 294) and Dr. Thomson, of carbonic acid, ammonia, and water, in the following proportions:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per centage.</th>
<th>R. Phillips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonic Acid</td>
<td>3</td>
<td>66</td>
<td>55.93</td>
</tr>
<tr>
<td>Ammonia</td>
<td>2</td>
<td>34</td>
<td>28.81</td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>18</td>
<td>15.26</td>
</tr>
<tr>
<td>Hydrated Sesquicarbonate of Ammonia</td>
<td>2</td>
<td>118</td>
<td>100.00</td>
</tr>
</tbody>
</table>

IMPURITIES.—This salt is met with in the shops of various degrees of purity. If pure, it should dissolve acids without depositing any blackish matter; it should leave no residuum when heated on platinum or glass.
should be translucent, and not opaque and pulvem; and, lastly, its
lution, saturated with pure nitric acid, should give no precipitate with
dioxide of barium or nitrate of silver, for the first would indicate sul-
phuric acid or a sulphate, the second hydrochloric acid or a chloride.

**Physiological Effects** (a.) **On vegetables.**—[See Ammonia.]

(b.) **On animals.**—The principal experimenters with this salt are
Seybert, Orfila, and Gaspard, on dogs, and Wibmer on man. Seybert
quoted by Wibmer, *die Wirkung, &c.*) injected in one experiment
teen grains, in a second twenty-five grains, and in a third experiment
forty-five grains of this salt, dissolved in a little water, into the crural
in of a dog: the animal appeared to suffer great pain; the frequency
the heart's action was increased, the respiration became difficult, and
convulsions came on; but in all these cases perfect recovery
ok place. The blood drawn after the injection had the natural colour,
tour, and consistence. Orfila (*Toxicol. Génér.*) found that two drachms
d a half of the salt, given to a dog, caused gastric inflammation, with
tonic convulsions; the body ultimately becoming curved, with the
ad forcibly bent backwards. Gaspard (quoted by Wibmer) killed a
ung pig, of three weeks old, by injecting twenty-four drops of (a solu-
on of) carbonate of ammonia in an ounce of water into the veins.
eth occurred in nine hours.

c.) **On man.**—The principal experimenter here is Wibmer (*op. cit.*),
to made his trials on himself. He found that a grain and a half of this
lt produced no remarkable effect; three grains increased the frequency
the pulse from 68 to 72 beats per minute, with throbbing headache
other experiments, in which he took from six to twelve grains (in
ne repeating the dose at short intervals), the effects were usually, but
ot constantly, increased frequency of pulse, with disorder of brain,
imfested by the pain, heaviness, throbbing, &c. In one instance, he says,
sposition to cough, and increased secretion of bronchial mucus, were
markable.

From these and other experiments we infer, that the *local* action of
is salt is that of an irritant and corrosive; but it is much less powerful
an the caustic solution of ammonia, in consequence of the presence of
bonic acid, which in some degree neutralizes the alkaline properties of
m ammonia. Swallowed in *moderate doses* (of about 30 grains) it
asions vomiting: in *large doses* it excites pain, inflammation, and all
sequences of an irritant poison; while the immoderate
halation of its vapour is capable of giving rise to bronchial
flammation. The remote action of this salt is similar to that of caustic
mmonia. Thus, in small doses it has the same exciting action on the
art, brain, &c. and the same diaphoretic effect. We denominate it,
erfore, stimulant, sudorific, antispasmodic, antacid, and rubefacient.

Uses.—Sesquicarbonate of ammonia is used in the same cases and
nder the same circumstances as the solution of ammonia, to which,
erore, I must refer the reader. In some cases it is also employed in
duction of effervescing draughts. The following are the relative
portions of acid and base to be used:

20 grains of sesquicarbonate of ammonia \[ \frac{6}{21} \] fluiddrachms of lemon juice.
will saturate about \[ \frac{25}{6} \] grains of crystallized citric acid.

The *citrate* and *tartrate* of ammonia, obtained as above, are useful in
alaying nausea and vomiting; they are also feebly diaphoretic, and some easies diuretic.

Sesquicarbonate of ammonia has been employed as an emetic in paralysis. An ointment made of the finely pulverized salt and lard is a very useful rubefacient in rheumatic pains, sprains, &c. Mixed with some aromatic oil (as oil of lavender or bergamot) it is employed as a smell against syneope, hysteria, &c.

**Administration.**—As a stimulant and diaphoretic this salt is used in doses of from five to ten grains, exhibited either in the form of pill or solution. As an emetic the dose is 30 grains, properly diluted, as repeated if necessary.

**Antidotes.**—(See **Ammonia**.)

**Ammoniacal Soaps.**—When caustic ammonia is mixed with fatty bodies (such as olive oil, lard, or mutton suet), it forms a kind of soap, composed of the fatty acids, generated by the oil and of ammonia combined with them. Two of these compounds require to be noticed:

1. **Liniment of ammonia.**—This is prepared, according to the London Pharmacopoeia, by mixing a fluid ounce of solution of ammonia with two fluid ounces of olive oil. This compound, sometimes termed volatiliniment, is an oleo-margarate of ammonia; that is, a compound of oleic and margaric acids with ammonia. It is employed as an external stimulant and rubefacient, to relieve rheumatic and neuralgic pains, sore throat, and various other complaints in which cutaneous stimulants are likely to be useful. It is the

2. **Ointment of ammonia.**—In France an ointment is employed, called liparolé d’ammoniaque, or pommade ammoniacale de Grondret, and which is composed of eight parts of solution of ammonia, seven parts lard, and one part mutton suet. This compound, rubbed on the skin, and covered by a compress, speedily produces vesication: without the compress, it causes rubefaction, merely owing to the volatilization of the ammonia. It is a very useful counter-irritant and vesicant.

**Liniment of sesquicarbonate of ammonia.**—This is prepared by mixing a fluid ounce of the solution of the sesquicarbonate of ammonia with three fluid ounces of olive oil. It forms an imperfect kind of salt owing to the presence of carbonic acid. Its uses are analogous to those of the liniment of ammonia before mentioned.

**Ammonia Bicarbonate.—Bicarbonate of Ammonia.**

**History and Synonymes.**—This salt was formed by Berthollet, and hence it is sometimes termed **Berthollet’s neutral carbonate of ammonia**.

**Preparation.**—In the Dublin Pharmacopoeia it is ordered to be prepared by passing a stream of carbonic acid through a solution of ten parts of sesquicarbonate in fifteen parts of water, until the sesquicarbonate be saturated. It is then allowed to remain at rest, and crystals are deposited, which are to be dried without heat, and preserved in a close vessel.

**Properties.**—This salt crystallizes in irregular six-sided prisms, has little or no smell, and less taste than the sesquicarbonate. It is less soluble than the last-mentioned salt, and its solution does not precipitate the magnesian salts, by which circumstance it may be distinguished from the carbonate of ammonia.
COMPOSITION.—The composition of this salt is the following:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>17</td>
<td>21.5</td>
<td>19</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>2</td>
<td>44</td>
<td>55.7</td>
<td>56</td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>18</td>
<td>22.8</td>
<td>25</td>
</tr>
</tbody>
</table>

PhySIOLOGICAL EFFECTS AND USES.—The operation and uses of this Salt are analogous to those of the preceding compounds of ammonia. It termed diaphoretic, antispasmodic, and antacid. Being less caustic, is more palatable than the other carbonates (Barker and Montgomery's Observations on the Dublin Pharmacopeia).

ADMINISTRATION.—The dose of it is from six to twenty-four grains, dissolved in cold water.

**Ammoniæ Hydrochloras.—Hydrochlorate of Ammonia.**

HISTORY AND SYNONYMS.—The early history of this salt is involved considerable obscurity; for though the term *sal ammoniacus* (*άλχ αμμωνία*), is met with in several old writers, it is believed, by the erudite Hoffmann (Hist. of Inventions, vol. iv. p. 370), as well as by others, to refer to rock-salt. The first distinct notice of hydrochlorate of ammonia is to be met with in Geber, who was acquainted with the mode of preparing it by sublimation. But, as my friend Dr. Royle observes, in his Essay on the Antiquity of Hindoo Medicine (p. 41), this salt "must have been familiar to the Hindoos ever since they have burnt bricks, as they now do, with the manure of animals; as some may usually be found distilled at the unburnt extremity of the kiln.

The substance, whatever its nature may be, which the ancients termed *ammoniac*, derived its name from *Ammonia*, the name of a district of Bya where the oracle of Jupiter Ammon was situated. This district bore its name from *άμμας, sand*, on account of the nature of its soil. Herodotus (lib. iv., cap. 181 et 2) mentions the salt found in this district.

Few substances have had so many synonyms as the hydrochlorate of ammonia; but of those I shall only mention such as are now in use, *muriate of ammonia, sal ammoniac, and chloride of ammonium*. Other synonyms I must refer to Dr. T. Thomson's Hist. of Chem. vol. i. p. 125, and Parr's Med. Dict., art. Ammoniacus.

NATURAL HISTORY.—(See Ammonia).

PREPARATION. (a.) By the destructive distillation of bones.—Bones are heated to remove the fatty matter, which is used in soap making. The larger and finer pieces are then picked out for the manufacture of tongs, handles of tooth-brushes, of knives, &c.; while the smaller and fine portions are sold as manure. The remaining pieces are distilled. The still or retort is made of cast iron or of Welch bricks. In a
large manufactory (fig. 44) in this metropolis, the retort (which is made of Welch bricks) is placed perpendicularly in the furnace. Its shape is a right rectangular prism, the height being twenty feet; the length about three feet, the breadth two feet: it is closed at both top and bottom by a moveable iron plate, and the fire is made around it. The bones are introduced at the upper end of the retort. The volatile products are conveyed (by an iron pipe, which opens into the upper part of the retort) first into water, and then into an iron receiver (in some places an old steam boiler is employed as a receiver) where the brown ammoniacal liquor (bone spirit) and the empyreumatic oil (animal oil) are deposited. The non-condensable portion is a fetid inflammable gas: this, after passing through water contained in a second receiver (a cask or vat), is conveyed into a chimney, or is burned. The solid residue in the retort is removed, while red hot, through the lower and underground end of the retort into wrought-iron canisters, which are instantly closed by iron covers, luted to make them air tight, and then raised to the surface by crane. When cold, it is powdered and sold as ivory black. A coarse powder is employed by sugar refiners for decolorizing saccharine liquids.

The products of this operation are easily accounted for. When bones are heated, their cartilaginous or gelatinous portion undergoes decomposition, and its elements (carbon, hydrogen, nitrogen, and oxygen) enter into new combinations. Some of the oxygen and hydrogen unite to form water. Carbon and oxygen, combining in different proportions, furnish carbonic oxide and acid. Carbon with hydrogen forms carburetted hydrogen; while nitrogen uniting with hydrogen produces ammonia, which, with some carbonic acid, forms carbonate of ammonia. The empyreumatic oil consists of carbon, hydrogen, and oxygen, with probably some nitrogen.

The carbonate of ammonia contained in the bone spirit is converted...
to sulphate, either by the addition of sulphuric acid, or by digestion of ground plaster of Paris (sulphate of lime). In the first case carbonic acid is evolved, in the latter we get carbonate of lime formed, from which the solution of sulphate of ammonia is separated by filtering. By evaporation, the solution yields brown crystals of sulphate of ammonia. This is sublimed with common salt, by which we obtain sulphate of soda and hydrochlorate of ammonia. Every equivalent or 57 parts of sulphate of ammonia re-act on one equivalent or 60 parts of chloride of sodium, and with one equivalent or 9 parts of water produce one equivalent or 54 parts of hydrochlorate of ammonia, and one equivalent or 72 parts of sulphate of soda.

**Ingredients Used.**

<table>
<thead>
<tr>
<th>1 eq. Ammonia</th>
<th>1 eq. Ammonium Sulphate</th>
<th>1 eq. Water</th>
<th>1 eq. Hydrogen</th>
<th>1 eq. Oxygen</th>
<th>1 eq. Chlorine</th>
<th>1 eq. Sodium</th>
<th>1 eq. Sulphate Soda</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>17</td>
<td>9</td>
<td>1</td>
<td>8</td>
<td>36</td>
<td>24</td>
<td>72</td>
</tr>
</tbody>
</table>

### RESULTS.

**(b) From coals.**—In the distillation of coal as practised at the gas-works, the volatile matters are conveyed to a condensing vessel or retortary, in which are deposited tar and an ammoniacal liquor which contains several salts of ammonia—as the sulphate, carbonate, hydrocyanate, and hydro sulphate. On the addition of sulphuric acid the carbonate, hydrocyanate, and hydro sulphate are decomposed, and by evaporation brown crystals of sulphate of ammonia are obtained. This salt is mixed with chloride of sodium, and heated in an iron pot lined with clay, to which a leaden head having an open cylindrical tube adapted (fig. 45). The hydrochlorate of ammonia is sublimed into the top of the apparatus. In the clay removed from the pots after the operation, small but perfect and beautiful crystals of the bisulphuret of iron are sometimes found. They are formed during the process. In some cases the gas liquor is saturated with hydrochloric acid, and the brown crystals of hydrochlorate obtained by evaporation are purified by sublimation. The above is a sketch of the process which I saw in operation a few years since at the Westminster Gas Works. At the present time the gas is sold to sal ammoniac manufacturers, who reside in the outskirts of the metropolis.

### Properties.

Hydrochlorate of ammonia usually occurs in commerce in the form of large hemispherical cakes, which are translucent, and by exposure to the atmosphere become slightly moist. By solution or sublimation it may be obtained in regular octahedral, or cubic, or plnnoose crystals. Its sp. gr. is 1.450. Its taste is saline and acrid; it has no smell. When heated, it sublimes without undergoing fusion or decomposition. It is soluble in about 3 parts of cold and 1 of boiling water: 1 being produced during the solution. It dissolves in alcohol.

### Characteristics.

It may be recognized by the following characters: It is white and volatile; and if heated on the point of a knife by the heat of a candle, it readily sublimes. Mixed with caustic potash, or sulphuric acid, it evolves ammoniacal gas, which is known by its odour, its volatile nature, and the formation of carbonic acid gas.

**Fig. 45.**

**Sublimation of Hydrochlorate of Ammonia.**
acid. Dissolved in water the hydrochlorate of ammonia produces with a solution of nitrate of silver a white precipitate of chloride of silver recognized by the properties before described (see p. 105): and with chloride of platinum a yellow precipitate (the platino-chloride of ammonia) which when collected, dried, and ignited, yields spongy platinum.

Composition.—The following is the composition of this salt:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>17</td>
<td>31'48</td>
</tr>
<tr>
<td>Hydroch. Acid</td>
<td>1</td>
<td>37</td>
<td>68'51</td>
</tr>
</tbody>
</table>

If one equivalent or two volumes of hydrochloric acid gas be mixed with one equivalent or two volumes of ammoniacal gas, combination is effected; the gases disappear, heat is evolved, and the white hydrochlorate deposited.

Analogy would lead us to regard this salt as a chloride of some metallic base. If such a base exist, it must consist of one equivalent nitrogen and four equivalents hydrogen. Berzelius assumes the existence of this hypothetical metallic base, and calls it ammonium, while sal ammoniac is termed by him chloride of ammonia. The protoxide of this suppositions metal will be equal to an equivalent of ammonia and one of water. The advantages of this hypothesis are that it obviates certain difficulties respecting the compounds formed from ammonia with the hydrazides, and readily explains the formation of the ammoniacal amalgams: its disadvantages are, that it constrains us to admit the existence of two bodies (ammonium and its protoxide) hitherto not known to exist.

Impurities.—The hydrochlorate of ammonia is sometimes rendered impure by the presence of chloride of iron. I have met with cakes of this salt which when broken presented thin, yellow, concentric laminae of what I believe to be a double salt of chloride of iron and hydrochloride of ammonia. That the chloride of iron performs, in this yellow compound, the function of an acid, is shown by its not striking a bluish colour on the addition of the ferrocyanamuret of potassium.

Physiological Effects. (a.) On Vegetables.—According to Sir Davy (Agric. Chem.) water holding in solution 1:300 of its weight of hydrochlorate of ammonia promotes vegetation. Solutions which contained 1:30 of their weight of this salt he found to be injurious.

(b.) On Animals.—Courten (Phil. Trans. for 1712), Sprögel, Vibo and Gaspard (quoted by Wibmer, die Wirkung, &c.), injected solution of sal ammoniac into the veins of animals (dogs and horses): large doses generally caused convulsions, sometimes paralysis, and death. From observations of Orfila, Smith, Arnold (Wibmer, op. cit.), and Moine (Pharmacol. Vétérinaire), this salt appears to be a local irritant, when introduced into the stomach in large quantities causes vomiting, purging, and gastro-enteritis. It exercises a specific influence on distant organs, for the three first of the above-mentioned experiments observed that inflammation of the stomach ensued, to whatever part of the body the salt might have been applied, and the convulsions and paralysis before referred to, attest its action on the nervous system. Arnold says it diminishes the plasticity of the blood.

(c.) On Man.—Wibmer tried this salt on himself. He took from
twenty grains for a dose, which he repeated at the end of an hour. The effects were a sensation of warmth and oppression in the stomach, headache, and increased desire of passing the urine.

In this country it is so rarely employed internally that we have very little experience either of its physiological or of its therapeutical effects. Germany, where it is more frequently administered, it is in high repute as a powerful alterative or resolvent. "Like most salts," says Sundelin (Handbuch der speciellen Heilmittelehre, 1st Bd. p. 150, 3rd ed.), "sal ammoniac operates on the alimentary canal as an excitant." After its absorption it appears to reduce moderately the action of the heart and large arteries, and, in this respect, belongs to debilitative or temperant agents. But it acts as excitant and irritant to the mucous and arterial capillary systems, to the lymphatic vessels and glands, to the skin, to the kidneys, and especially to the mucous membranes; not only increasing secretion but also improving nutrition and dilatation, and counteracting organic abnormal conditions, (as tumors, echenings, and relaxations), so frequently met with in those structures. It promotes not only the mucous secretions but also cutaneous exhalations, and even menstruation. Its diuretic effects are less obvious. It tends its stimulating influence to the serous and fibrous tissues, whose irritation it improves.

From these statements it follows that sal ammoniac operates like the pre-profoundly-acting alterative agents, and even approaches, in many respects, mercury, but is especially distinguished from the latter in this, that it by no means acts to such a degree as a defluxing, nay even melting, agent on solidified organic substance and its crisis, and by its not so powerfully stimulating the lymphatic system. Its long-continued use may, indeed, injure the digestive powers, but never gives rise to general cachexia. It was administered large doses of it against thickening of the mucous membrane, for months, without remarking any injurious effects beyond those just mentioned. In large doses it purges like other salts, but in small ones rather constipates." Kraus (Heilmittelehre, p. 309) says, that light miliary eruption and very painful aphthæ have been produced by large doses of it.

Uses.—In this country it is rarely employed internally. In Germany, where it is frequently used, it is administered in the following cases:—

In mild inflammatory fevers, especially those complicated with exhalations of the mucus or fibrous membranes, as in the diseases called acute, gastric, catarrhal, or rheumatic fevers, it is employed for promoting secretion and hastening critical discharges.

In inflammation of the mucous or serous membranes, as catarrh, enteritis, urethritis, peritonitis, pleuritis, &c. when the first violence of disease has been subdued, but when the secretions and exhalations have not yet established. In these cases it is used as a substitute forcury.

In chronic diseases of various kinds, as chronic inflammation of the liver, spleen—enlargement of the mesenteric glands—induration of the prostate, uterus, and ovaries—catarrhus vesicae—chronic catarrh of the uterus—mucous discharges from the urethra and vagina, is administered as an alterative, as a stimulant to the absorbent system, and as a promoter of healthy secretion.

In amenorrhœa it is strongly recommended by Sundelin (op. cit.), as
an emmenagogue, in those cases in which the disease depends on, or is connected with inactivity of the uterus.

Externally it is sometimes employed, on account of the cold produced during its solution, in headache, mania, apoplexy, &c. When used for this purpose it must be applied as soon as the salt is dissolved. Mr. Walker (Phil. Trans. 1801, p. 120) found that two parts of this salt with five parts of nitrate of potash and sixteen parts of water, lowered the thermometer from 50° F. to 10° F. A mixture of this kind placed in a bladder has been recommended by Sir A. Cooper as an application to hernial tumors. It may be applied to the head instead of ice.

Sal ammoniac has been employed externally as a stimulant, or resolver or discutient. Dr. Paris (Pharmacologia) strongly recommends the following stimulant and rubefacient plaster in pulmonary complaints and in rheumatic affections of the muscles of the chest: soap &i. lead plaster 5ij., liquified together, to which, when nearly cold, is added of hydrochlorate of ammonia finely powdered, 5ss. The efficacy of this plaster depends on the evolution of ammoniacal gas in consequence of the action of the alkali of the soap on the hydrochloric acid of the hydrochlorate; hence it should be renewed every twenty-four hours. A strong solution of sal ammoniac (as one or two ounces of the salt to twelve ounces of water) is employed in the cure of contusions and ecchymosis, unaccompanied by any wound of the skin; in chronic tumors, as of the breast, in local dropsies, as hydrocele and dropsy of the thyroid gland; in chilblains; in saphanel after the requisite scarifications, &c. Weak solutions (as from one to four drachms of the salt to a pint of water) are employed as washes in scabies and ulcers, as gargles in cynanche, and as injections in gonorrhœa and leucorrhœa. This salt in powder sometimes used as a tooth-powder.

Administration.—For internal use the dose of it is from five to thirty grains every two or three hours, either in a pulverent form, combined with sugar or gum, or in solution with some saccharine or mucilaginous solution, to which an aromatic should be added.

Antidote.—In the event of poisoning by this salt, warm water and mucilaginous and demulcent liquids should be given to promote vomiting. No chemical antidote or counterpoison is known. Gastro-enteritis is of course to be combated by the usual means.

Liquor Ammoniæ Acetatis.—Solution of Acetate of Ammonia.

History and Synonymes.—This solution appears to have been first described in 1732, by Boerhaave, who introduced it into the Materia Medica. It was subsequently employed by Minderer or Mindererus and hence obtained one of its names, spiritus seu liquor Mindereri.

Natural History.—Acetate of ammonia is, I believe, always an artificial compound.

Preparation.—In the London Pharmacopœia this compound is ordered to be prepared by dissolving, in four pints of distilled vinegar, four ounces and a half (or as much as may be sufficient to saturate the acetic acid) of sesquicarbonate of ammonia. Every equivalent, or 51 parts
Acetic acid, unite with one equivalent, or 17 parts of ammonia; while ne and a half equivalents, or 33 parts of carbonic acid, are evolved.

**INGREDIENTS USED.**

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq. wt.</th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
<td>63</td>
</tr>
</tbody>
</table>

Crystallized Acetate Ammonia 1 131 99.999

The quantity of dry or anhydrous acetate of ammonia contained in the solution kept in the shops, varies with the strength of the distilled vinegar. Now, according to Mr. Phillips, 100 grains of distilled vinegar would saturate 13 grains of crystallized carbonate of soda. This would indicate the presence of 4.6 per cent. of acetic acid; and, consequently, 90 grains of liquor ammoniac acetasit, prepared from such vinegar, would consist of

| Acetate of Ammonia | 6.040 |
| Water | 93.959 |

**LIQUOR AMMONIAC ACETATIS.**

**RESULTS.**

<table>
<thead>
<tr>
<th>eq. Sesquicarb.</th>
<th>1 eq. Carb. Acid 33</th>
<th>1 eq. Carbonic Acid</th>
<th>33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amm. 50 51 eq. Ammonia</td>
<td>17</td>
<td>1 eq. Acetate Ammonia</td>
<td>68</td>
</tr>
</tbody>
</table>

In the above diagram no notice has been taken of the water in the hydrated sesquicarbonate of ammonia, nor of that in the vinegar.

**PROPERTIES.—**When pure, this liquid is colourless. Any tint, therefore, which the solution of the shops may have, is referrible to impurities either the vinegar or the sesquicarbonate. Filtering it through powdered animal charcoal will usually remove any yellow or brown colour which it may have. If quite neutral, it will affect neither turmeric nor mus paper. It is better, however, to have a slight excess of acid present than of sesquicarbonate; for if the latter predominate, the solution much more irritant; and if employed as a eollyrium, might produce convenient results.

**CHARACTERISTICS.**—It is totally dissipated by heat. When concentrated it evolves vapours of acetic acid on the addition of strong sulphuric acid, and gives out ammonia if potash or lime be mixed with it.

**COMPOSITION.—**By evaporating a saturated solution of acetate of ammonia under the exhausted receiver of the air-pump, and over sulphuric acid, crystals of the acetate are obtained. They are transparent brique rhomboidal prisms, and consist, according to Dr. Thomson, of

Acetate of Ammonia 6.040
Water 93.959

**IMPURITIES.—**This solution ought neither to be discoloured by the action of hydro sulphuric acid, nor to throw down any precipitate by nitrate of silver or chloride of barium. These substances, therefore, may be employed to detect, respectively, metallic matter, hydrochloric acid or chloride, and sulphuric acid. Pure acetate of ammonia occasions no precipitate with diacetate or acetate of lead; but the liquor ammoniac acetasit of the shops usually does, owing to the presence of some free acetic acid or sesquicarbonate of ammonia.

**PHYSIOLOGICAL EFFECTS.—**In small doses this solution is regarded as irritant and refrigerant: in large doses, diaphoretic and diuretic. These effects, however, are not very obvious. Wibmer (die Wirkung, &c.) ok it in moderate doses, yet did not observe any diaphoretic, diuretic,
or purgative effects from it; but he experienced headache and disturbance of digestion. Dr. Cullen (Mat. Med.) says, "I have known four ounces of it taken at once, and soon after four ounces more, without any sensible effect." The local operation of this solution is that of a mild stimulant.

Uses.—(a.) Internal.—It is employed in febrile and inflammatory diseases, and forms a constituent of the ordinary saline draught. It is given in conjunction with nitrate of potash, or tartar emetic, and sometimes with camphor and opium. When administered as a diaphoretic its operation is to be promoted by the use of tepid diluents and external warmth. Its diuretic effect is assisted by keeping the skin cool, and conjointly the spirit of nitric ether.

(b.) External.—Diluted with water it is sometimes applied as a delicate wash to inflamed and bruised parts. Mixed with six or seven times its volume of rose-water, to which a drachm or two of tincture of opium may sometimes be added, it is employed as a collyrium in chronic ophthalmia.

Administration.—It is given in doses of half a fluid ounce to two or three ounces every five or six hours.

Order 7.—Carbon, and its Compounds with Oxygen, Hydrogen, and Nitrogen.

Carb'onium.—Car'bon.

History.—The term carbon (from carbo, ònis, coal) was first employed by Morveau, Lavoisier, and Berthollet, to designate the pure matter of charcoal. To the second of these chemists, we are indebted for demonstrating, that by combustion in oxygen gas the diamond and charcoal yield the same product; namely, carbonic acid gas.

Natural History.—Carbon is found in both kingdoms of nature:

(a.) In the inorganic kingdom.—When pure and crystallized it constitutes the diamond, which Sir D. Brewster (Edinb. Phil. Journ vol. iii. p. 98, and Philosoph. Mag. vol. i. p. 147, 1827) suspects to be of vegetable origin; but a specimen described by Mr. Heulans (Geol. Trans., 2nd series, i. 419), was found in a primary rock. Plumbago and anthracite consist principally of carbon. The bituminous substances (as coal, petroleum, naphtha, &c.) also contain it. These are admitted by geologists to be of vegetable origin. Carburetted hydrogen is evolved from coal strata, marshy places, stagnant waters, &c. Carbonic acid is found either in the free state, as in the atmosphere, in mineral waters evolved from the earth in old volcanic countries, &c., or combined with metallic oxides, in the form of the carbonate of lime, iron, &c. It is remarkable that carbon is rare among the older rocks (De la Beche, Researches in Theoretical Geology, p. 32).

(b.) In the organized kingdom.—Carbon is an essential constituent of all organized beings, vegetable or animal.

Properties.—Carbon is a solid, odourless, tasteless substance, neither fusible nor volatile; combustible in oxygen gas, yielding carbonic acid gas. Its equivalent by weight is 12. Some years since Dobereine asserted that he had discovered a metallic basis in it, but his statement has not been confirmed.

The other properties of carbon are so varied, that chemists are obliged
admit distinct varieties of this substance: the principal are the mond, plumbago, and charcoal (animal and vegetable). Of these the latter only require consideration in this work.

1. Plumba'go.—Graph'ite or Black Lead.

History.—This substance was probably known to the ancients; but was first accurately distinguished from other bodies with which it had been previously confounded, especially with molybdena (bisulphide of molybdenum), by Scheele (Essays, p. 246), in 1779. The terms plumbago, mbum nigrum, and molybdena, met with in Pliny (Hist. Nat.), do not apply to graphite.

Natural History.—It is found in various parts of the world; chiefly in primitive rocks and the coal formations. The finest occurs at Borrowdale, in Cumberland. It is brought to London, and sold by auction, at a public-house in Essex-street, Strand, on the first Monday every month. The best quality usually sells for two guineas or more a pound, and is employed for making pencils. The ordinary kinds of this country are imported from Ceylon and Hamburg.

Properties.—It occurs either crystallized in regular six-sided prisms, in kidney-shaped masses, or disseminated in rocks. Its colour is iron steel-grey, with a metallic lustre. It has a greasy feel, and writes readily on paper. Its specific gravity is 2.08 to 2.45.

Characteristics.—It is known to be a variety of carbon by its yield of carbonic acid when burned in oxygen gas. Its physical properties distinguish it from most other varieties of this element. Some kinds of coal-gas charcoal closely resemble it. Of non-carbonaceous substances, molybdena (bisulphide of molybdenum) is the only substance that can be confounded with it in external appearance.

Composition.—It consists essentially of carbon, but is mixed with variable properties of iron and other substances. The following are analyses of three varieties by Vanuxen (Silliman's Journal, vol. x. 105):

<table>
<thead>
<tr>
<th></th>
<th>Borrowdale (pure)</th>
<th>Borrowdale (impure)</th>
<th>Bustletown (pure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>88.37</td>
<td>61.27</td>
<td>95.4</td>
</tr>
<tr>
<td>Water</td>
<td>1.23</td>
<td>5.33</td>
<td>0.6</td>
</tr>
<tr>
<td>Silica</td>
<td>5.10</td>
<td>10.10</td>
<td>2.6</td>
</tr>
<tr>
<td>Alumina</td>
<td>1.00</td>
<td>3.20</td>
<td>0.0</td>
</tr>
<tr>
<td>Oxides of Iron, Manganese, &amp;c.</td>
<td>3.60</td>
<td>20.60</td>
<td>1.4</td>
</tr>
</tbody>
</table>

99.30            | 99.90             | 100.0

Aspect, however, that the finest varieties of the Borrowdale graphite contain a less quantity of foreign matter than is here stated. On the position that the carbon was chemically combined with iron, graphite is formerly called carburet or percarburet of iron. From some observations of Schrader's, however, it would appear that the iron is in combination with titanic acid.

Physiological Effects.—Various properties have been assigned to but farther evidence is wanting to establish its action on the body. Lander (ausführliche Arzneimittellehre, 3rd. Bd. p. 486) says it alters in some way the lymphatic secretion and the condition of the skin, and in some days' use, causes increased secretion of urine, with difficulty passing it.
USES.—It has been employed both externally and internally in chronic diseases of the skin (as herpes). When used externally, it is mixed with lard in the proportion of one or two draehms to an ounce of the latter. Internally the dose is ten or twelve grains to a draehm.

2. Car'bo Lig'ni.—Wood Char'coal.

HISTORY.—Wood charcoal must have been familiar to man from the most remote period of antiquity, and was probably known to the inhabitants of the globe. For an account of the ancient method of preparing it, I must refer the reader to the works of Theophrastus (cap. and Pliny (Hist. Nat. lib. xvi., cap. vii).

NATURAL HISTORY.—Wood charcoal is always an artificial product. Some samples of Bovey coal have very much the appearance of wood charcoal, but are readily distinguished by their containing hydrogen, a consequence of which they burn with a yellow flame. Moreover they are not good conductors of galvanic electricity (Kidd’s Outlines Mineralogy, vol. ii. p. 47.)

PREPARATION.—Ordinary wood charcoal is prepared, on the large scale, for the purposes of fuel, by burning billet-wood piled in a conical heap, covered by turf and sand, to prevent the access of atmospheric air, a few holes being left near the bottom and one at the top, to occasion a draught. The heap is then set fire to, and when the flame has pervaded the whole mass, the holes are closed. When cooled, the billets are found converted into charcoal. For an account of the modes of arranging the wood in heaps, consult Dumas, Traité de Chimie, applic aux Arts, t. i., p. 561.

The wood charcoal used in the manufacture of gunpowder is obtained by heating wood in cast iron cylinders, the gaseous products being allowed to escape. The woods used for this purpose are Dogwood (Cornus sanguinea), the common alder (Alnus glutinosa), and the willow (Salix).

PROPERTIES.—Wood charcoal is black, odourless, and insipid. It has the texture of the wood from which it has been obtained. It is brittle and may be easily pulverized, especially when hot. Though a very bad conductor of heat, it is an excellent conductor of electricity. It is insoluble, infusible, and incapable of volatilization. Its specific gravity varies, according to the substance from which it has been obtained. A remarkable property possessed by it is that of abstracting certain substances (such as hydrox sulphuric acid, organic colouring principles, various odorous matters, &c.) from liquids in which they are dissolved or through which they are diffused. Another curious quality is that of condensing, within its pores, a certain quantity of any gas with which it may be placed in contact. One volume of box-wood charcoal absorbs 1.75 volumes only of hydrogen gas, but 90 volumes of ammoniacal gas. Some of the properties now mentioned (as that of decolorizing) are possessed in a more eminent degree by animal charcoal.

CHARACTERISTICS.—By burning in oxygen gas, charcoal yields carbonic acid gas; a property by which it is shown to consist of carbon. Its texture and appearance will distinguish it from other forms of carbon.

PHYSIOLOGICAL EFFECTS.—Wood charcoal I believe to be an in
bstance both with respect to animals and vegetables. Burdin (quoted
the Dict. de Mat. Méd. of MM. Merat and de Lens) gave a pound of
daily without producing any other effect than that of blackening the
bols. A variety of properties and virtues have, however, been ascribed
it, as I believe, without foundation: thus it has been termed anodyne,
menagogue, tonic, purgative, &c. In Hahnemann’s Traité de Matière
édicale (traduit par A. J. L. Jourdan), no less than thirty-five pages are
upied with the enumeration of the symptoms produced by less than
e-millionth of a grain of this substance!!

Uses.—In this country, charcoal is used as a therapeutic agent, prin-
sally as a disinfectant and antiseptic, to absorb the fetid odour evolved
gangrenous and phagedenic ulcers. For this purpose it may be used
the form of powder or of poultice. Its disinfecting and antiseptic
owers, however, are much inferior to those of chlorine, or of the chlo-
es of lime and soda. As a tooth-powder it is a valuable agent, freeing
the teeth from the foreign matters which cover them, and at the same
time counteracting the unpleasant smell of the breath arising from
cayed teeth or disordered stomach. Brachet (Considerations sur
usage du Carbon en Médecine, Paris, 1803) states, that it checks caries
of the teeth. Areca nut charcoal is a favourite variety for tooth-pow-
ners. Internally, charcoal has been exhibited in various afflictions of
the alimentary canal, such as dyspepsia, cardialgia, diarrhœa, and dysen-
ny. The beneficial effects said to have been produced in these cases
ly be referred to the action of charcoal on the secretions of the
bills; an explanation apparently supported by Dr. Chapman’s state-
ment, that in dysentery, where the stools are highly acrid and offensive,
charcoal entirely divests them of their bad smell and acrimony. In
sequence of the advantage said to have been obtained by Dr. Cal-
rgo, of Sicily, by the use of charcoal in intermittents, it was tried by
Calvert, physician to the British forces at Palermo, and with suc-
ess. (Edinb. Med. and Surg. Jour. vol. x., p. 15). In this country, how-
er, it is, I believe, never resorted to in ague by medical practitioners.
Daniel, of Savannah, has recommended it in obstinate constipation,
the nausea and confinement of bowels which frequently attend
agnancy. It has also been used in various other diseases, but expe-
ience has not confirmed its efficacy.

Administration.—The dose of charcoal, as ordered by different
iters, varies from ten grains to a table-spoonful or more.
In the Dublin Pharmacopoeia there is a formula for a wood charcoal
poultice (cataplasma carbonis ligni). It may be prepared by mixing
cely powdered charcoal with a common linseed poultice; it is applied
toul ulcers to destroy their offensive odour.

3. Carbo Animalis.—Animal Charcoal.

History and Synonymes.—This substance must have been known
the most ancient times. The kind usually met with in the shops
pared from bones, and is termed bone black, or, more commonly,
ry black, (ebur ustum nigrum).
Natural History.—It is always an artificial product.
Preparation.—The mode of preparing animal charcoal from bones
been already described. (See Ammoniac Hydrochloras).
PROPERTIES.—In its general properties animal charcoal agrees with charcoal procured from wood. The decolorizing powers of the former are, however, much superior to those of the latter.

COMPOSITION AND PURIFICATION.—Animal charcoal, prepared by calcining the bones of the ox, sheep, and horse, consists of the following ingredients, (Dumas, Traité de Chimie, t. i., p. 450):

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphate of Lime</td>
<td></td>
</tr>
<tr>
<td>Carbonate of Lime</td>
<td></td>
</tr>
<tr>
<td>Charcoal</td>
<td>10.0</td>
</tr>
<tr>
<td>Carburet or Silicate of Iron</td>
<td>2.0</td>
</tr>
<tr>
<td>Sulphuret of Calcium or Iron</td>
<td></td>
</tr>
<tr>
<td>Common Bone Black</td>
<td>100.0</td>
</tr>
</tbody>
</table>

For the ordinary purposes of the arts, as sugar refining, this impure animal charcoal answers very well, because the earthy salts in no way affect the process. But in various pharmaceutical operations the presence of phosphate and carbonate of lime would preclude the use of animal charcoal, on account of the free acid in the liquids to be decolorized. Hence the necessity of the purification of animal charcoal.

In the London Pharmacopoeia purified animal charcoal (carbo animalis purificatus) is ordered to be prepared by digesting for two days with a gentle heat, a pound of animal charcoal in a mixture of twelve fluid ounces of hydrochloric acid and the like measure of water, frequently shaking them. After pouring off the supernatant liquor the charcoal is to be washed with water until no acid is perceptible, and then dried.

In the above process the hydrochloric acid dissolves the phosphate of lime and decomposes the carbonate of lime and sulphuret of calcium, evolving carbonic and hydrosulphuric acid gases, and forming chlorides of calcium, which remains in solution.

Purified animal charcoal causes no effervescence when mixed with hydrochloric acid, nor is any precipitate produced by the addition of ammonia or its sesquicarbonate to the acid. For effervescence would indicate the presence of carbonate of lime, while a precipitate with sesquicarbonate of ammonia would shew either phosphate or carbonate of lime: if phosphate, caustic ammonia would also occasion a precipitate.

Animal charcoal, when deprived of its saline matters, usually contains traces of nitrogen. Döbereiner, indeed, supposed it to be a kind of subnitruret of carbon composed of one equivalent or 14 parts of nitrogen and six equivalents or 36 parts of carbon. Bussy, however, has shown that though animal charcoal retains its nitrogen with considerable obstinacy, yet that the latter may be separated by heat.

PHYSIOLOGICAL EFFECTS.—The remarks already made in reference to the physiological effects of wood charcoal, apply equally well to animal charcoal.

USES.—The principal use of animal charcoal is as a decolorizing agent in various pharmaceutical processes, as in the preparation of sulphate of quinia, hydrochlorate of morphia, veratria, &c. The theory of its efficacy is imperfectly understood. The superior value of animal to vegetable charcoal is usually referred to the minute separation of the carbonaceous particles effected by the presence of other matters, as of
osphate of lime when bones are employed. Carbonate of potash is better for this purpose than phosphate of lime. The property possessed by minute particles of charcoal, of abstracting colouring matter from acids, depends, probably, on some chemical affinities existing between carbon and colouring matter. It is stated, in some works, that charcoal which has been once used cannot have its decolorizing property stored by a fresh ignition, unless it be mixed with some inorganic substance. This, however, is an error. The animal charcoal which has been used in sugar refining, is returned to the maker to be fresh ignited, and is then employed again, and this process of re-igniting, is, I am informed, repeated many times, without any loss of decolorizing power.

Acidum Carbonicum.—Carbonic Acid.

History and Synonymes.—Although the ancients were acquainted with the poisonous properties of carbonic acid gas, Dr. Black, in 1757, was the first who explained the nature of this substance. The spiritus halis of the ancients is evidently this acid, as is also the spiritus vestris or gas of Paracelsus and Van Helmont. Fixed air, acid vapour, or aerial acid, are other synonyms for it.

Natural History.—It is a constituent of both kingdoms of nature.

(a). In the inorganic kingdom.—Carbonic acid is a constituent of the atmosphere. In some parts of the world it is evolved from the earth in large quantities, particularly in old volcanic countries. Thus in the vicinity of the Lake of Laach, Bischof estimates the exhalation as equal to 60,000lbs. daily, or 219,000,000lbs., (equal to about 1,855,000,000 cubic feet) annually! (De la Beche, Theoret. Geology.) Some of the acid evolved in the Brohlthal, on the Rhine, is employed by him in the manufacture of chemical preparations on the large scale. Most persons familiar, by report, with the Grotto del Cane, near Naples. It is a cavity in a rock, through the fissures of which carbonic acid is evolved. It has received its name from the practice of putting dogs into it, who go down suffocated. The Valley of Poison, in Java, which has been described by Loudon, is another spot where this acid escapes from the earth. It is a cavity of an oval form, about three quarters of a mile in circumference, and from thirty to thirty-five feet deep; filled to the height about eighteen feet with carbonic acid gas. The bottom of it is covered with the skeletons of men and various other animals, who have fallen victims to its destructive operation. If a traveller should be so fortunate as to enter it, he cannot be sensible of his danger until too late to return. Mr. Loudon thrust a dog in; he fell in fourteen seconds. The fowl thrown in appeared to be dead before it reached the ground!! Carbonic acid gas is frequently met with in mines and wells; and is employed by miners choke damp (from the German dampf, vapour). Few mineral waters are without this acid, and in some it exists in such quantity as to give them a sparkling or effervescent quality (p. 146).

Lastly, carbonic acid is found (native) in combination with various substances; as with soda, baryta, strontian, lime, magnesia, and the oxides of manganese, zinc, lead, iron, and copper. According to Mr. De la Beche (cit.) the average amount of carbonic acid locked up in every cubic yard of limestone, is about 16,000 cubic feet.
It is produced in the burning of limestone (carbonate of lime) at lime kilns, and by the combustion of charcoal, coal, wood, coal gas, the firdamp of coal mines, and other combustibles containing carbon.

6. In the organized kingdom.—Carbonic acid gas is exhaled by plants in dark or shady places, and hence is met with in green-house especially during the night. Animals develope it in the process respiration, and, therefore, in crowded rooms, with imperfect ventilatio accidents have sometimes happened from the accumulated carbonic aci It is produced by the decomposition of organic matters, as during fermentation of saccharine fluids, and in the destructive distillation of animal substances: hence the danger of descending into brewers' vat Free or combined carbonic acid is found in the blood, urine, bones, &c.

Preparation.—Carbonic acid gas may be procured in various ways but for ordinary purposes is usually obtained by the action of some ac (usually hydrochloric) on carbonate of lime (as white marble). It is most readily prepared in a tubulated glass retort, and may be collect over water. The ordinary hydrochloric acid of the shops should be diluted with four or five times its volume of water. By the reaction one equivalent, or 37 parts of hydrochloric acid, on one equivalent, or parts of carbonate of lime, we obtain one equivalent, or 56 parts chloride of calcium, one equivalent, or 9 parts of water, and one equ valent, or 22 parts of carbonic acid.

**Ingredients used.**

| 1 eq. Carb. Lime | 50 | 1 eq. Hydrogen | 37 |
| 1 eq. Lime | 28 | 1 eq. Chlorine | 36 |

**Results.**

| 1 eq. Carbon. Acid | 22 |
| 1 eq. Chlor. Calc. |

**Properties.**—At ordinary temperatures and pressures carbonic ac is gaseous. In this form it is invisible, irrespirable, has a faint odor and a sharp taste. Its specific gravity is 1·5277. It is neither combustible nor a supporter of combustion, except in the ease of potassium which, when heated in this gas, takes fire, the products of the combustion being carbon and carbonate of potash. It extinguishes most burning bodies when introduced into it in the ignited condition. It reddens litmus feebly.

Under a pressure of 36 atmospheres at 32°, carbonic acid is a limp colourless liquid, which is insoluble in water and in the fat oils, but soluble in all proportions in alcohol, ether, oil of turpentine, and ear bur of sulphur. Its refractive power is much less than that of water. Its expanibility by heat is greater than that of gases; for when heat from 32° F. to 86° F., its bulk increases from 20 to 29 volumes, while the pressure of its vapour augments from 36 to 78 atmospheres.

By an intense degree of cold, liquid carbonic acid may be solidifie Thus, when the pressure is removed from this liquid by opening a stop cock in the condensing vessel, the cold produced by the expansion is so great, that a quantity of solid carbonic acid is formed. In this state is so intensely cold, that mercury, liquid chlorine, liquid cyanogen, & may be readily frozen by it. Being a very bad conductor of heat, may be handled with impunity.

**Characteristics.**—Carbonic acid gas is recognised by its feebly reddening litmus, by being incombustible and a non-supporter of combusti
CARBONIC ACID.

except in the case above mentioned), and by its forming, with a solution of lime or of baryta, a white precipitate, soluble in acetic acid.

The carbonates effervesce on the addition of acetic or hydrochloric acid. The evolved gas is known to be carbonic acid by the characters here stated. The soluble carbonates form white precipitates in solutions of lime or baryta.

COMPOSITION.—By burning charcoal in one volume or 16 parts, by weight, of oxygen gas, we procure one volume or 22 parts, by weight, of carbonic acid gas.

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<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.0018</td>
</tr>
</tbody>
</table>

CARBONIC ACID WATER (Aqua Acidii Carbonici).—At the ordinary temperature and pressure of the atmosphere, one volume of water absorbs a volume of carbonic acid gas, and acquires a sp. gr. of 1.0018. By doubling the pressure the quantity of gas absorbed is doubled, and so on other degrees of pressure; for Dr. Henry has shewn that the quantity of gas forced into water is directly as the pressure. In the United States Pharmacopœia five volumes of gas are ordered to be condensed one of water. This solution is called Artificial Seltzer Water. The addition of soda water, and soda water from the fountain or pump, are, in general, merely aqueous solutions of carbonic acid. Carbonic acid water is a sparkling liquid, reddening litmus, having a pungent, acidulous taste, and causing a white precipitate with lime water, which precipitate is dissolve by an excess of carbonic acid water.

PHYSIOLOGICAL EFFECTS. (a) On Vegetables.—Carbonic acid gas is injurious to seeds, and diminishes or stops their germination according to the quantity of acid present. An aqueous solution of carbonic acid applied to the roots of plants promotes vegetation. An atmosphere containing not more than 1/2 of its volume of carbonic acid promotes the etation of plants exposed to the solar rays, but is injurious to those which grow in the shade (Saussure, Recherches, p. 25, et seq.)

(b) On dead animal matter.—Carbonic acid gas retards the putrefaction of animal substances.

(c) On animals.—The respiration of carbonic acid gas is deleterious and fatal to all classes of animals. That it operates in these cases as a positive poison, and not merely by excluding oxygen, as some have supposed, seems to be proved by two facts:—firstly, that an atmosphere composed of 79 parts of carbonic acid and 21 of oxygen acts as a poison, although there is as much oxygen present as there is in atmospheric air; and, secondly, that one bronchial tube of the land-tortoise be tied, without any serious injury to the animal; but if, instead of tying it, the animal be made to inhale carbonic acid gas by it, death ensues within a few hours (Christison, Treatise on Poisons, p. 745, 3rd ed.). The impression produced on the pulmonary extremities of the vagus, by the carbonic acid in the lungs, is supposed by some physiologists to be the ordinary stimulus to inspiration. According to the experiments of Nysten (Recherches, p. 88), this gas may be injected into the venous system in large quantity, without stopping the circulation, and
without acting primitively on the brain; but when more is injected than the blood can dissolve, it produces death by distending the heart, when air is injected into the veins (see p. 23). Applied to the skin animals, free access of common air to the lungs being preserved, it produces, if the experiment be continued long enough, death.

(d.) On man.—If an attempt be made to inhale pure carbonic acid gas, the glottis spasmodically closes, so as to prevent the smallest portion from entering the lungs (Davy, Researches, p. 472). When mixed with more than twice its volume of air, this gas ceases to provoke spasm of the glottis, and may be taken into the lungs. In this case it gives rise to symptoms resembling those of apoplexy. It usually causes a sensation of tightness at the chest, uneasiness, giddiness, loss of muscular power, insensibility, and stertorous breathing, sometimes accompanied by convulsions or delirium. These symptoms are succeeded by asphyxia and death.

Applied to the conjunctiva it acts as an irritant, and excites pain, redness, and a flow of tears. Applied to the skin (care being taken that it is not inhaled) it produces a sensation of warmth and prickling or tingling, sometimes accompanied by pain, increased frequency of the pulse, sweating, and excitement of the nervous system. M. Collard de M. tigny (quoted by Dr. Christison) experienced weight in the head, obscurity of sight, pain in the temples, ringing in the ears, giddiness, and an undefinable feeling of terror. Taken into the stomach, dissolved in water or in the form of effervescing draughts, it allays thirst, and diminishes the preternatural heat, thus acting like the other dilute acids. If it is evolved in the stomach, it distends this viscus, excites eruptions, and checks both nausea and vomiting. It appears to promote the secretion of the alimentary tube, to assist the digestive process, to allay irritation, and to act as a refreshing and exhilarating substance. It is said to be diuretic and diaphoretic. Wöhler and Stehberger expressly state, that the use of carbonic acid did not increase the quantity of this substance in the urine (Duncan, Supplement to the Edinb. Disp. p. 223). When drunk too quickly, and in large quantity, water impregnated with the gas has been known to excite giddiness and intoxication (Fodéré, M. Légale); and it is probable that champagne is indebted to this substance for part of its intoxicating powers. Applied to ulcers and suppuring surfaces, carbonic acid gas acts as a stimulant, improves the quality of the discharge in ill-conditioned and indolent ulcers, retards the putrefaction of the secreted matters, diminishes the unpleasant odour of foul gangrenous sores, and promotes the separation of the dead and mortar parts.

Uses.—(a.) When inhaled.—In some diseases of the lungs, particularly phthisis, it has been proposed to mix carbonic acid gas with the atmospheric air breathed by the patient, with the view of lessening the stultifying influence of the oxygen, to diminish the quantity, and improve the quality of the matter expectorated, and at the same time to relieve the hectic symptoms. It is not at all unlikely that temporary relief might be gained by its employment; but difficulty is experienced in the matter of applying it. Of course, to be beneficial, it ought to be constantly inspired. Temporarily it is readily inhaled, by generating it in a large bottle or jar, and breathing it by means of a tube; but for its continual use, the only method that can be employed is to evolve the acid in
taken's chamber. In some parts of the continent a popular remedy for consumption is a residence in rooms or houses inhabited by cows; and the asserted beneficial effects are supposed to be in part attributable to the carbonic acid gas contained in the chamber; but, says Vogt (Lehrbuch der Pharmakodynamik, Bd. ii. S. 32), "we must not overlook the humid, id, balsamic vapour, with which the air of cow-houses is commonly pregnant."

(b) Taken into the stomach, carbonic acid is a most valuable remedy in checking vomiting, and diminishing irritable conditions of this viscus. The best mode of exhibiting it is, I believe, in the form of an effervescing draught, composed of citric acid and bicarbonate of potash. In fever, it is an excellent refrigerant; especially serviceable in those cases which accompanied with gastric irritation. In that form of lithiiasis ended with a white or phosphatic deposit in the urine, water impregnated with carbonic acid may be taken with advantage; but in this case common effervescing draught, (made of a vegetable acid, and a bonated alkali) cannot be substituted for carbonic acid water, since it communicates an alkaline property to the urine.

c. Cysters of carbonic acid gas have been employed in certain affections of the rectum and colon,—for example, ulceration of the rectum, especially when of the kind commonly denominated cancers.

d. A stream of carbonic acid gas has been applied to the uterus with best benefit, in a painful condition of this viscus, as I have already mentioned (at p. 54).

e. Applied to the skin, care being taken that the gas is not inhaled, it employed either in its gaseous form, or dissolved in water. It is, of course, adapted to those cases where it is desirable to excite the vascular system, especially of the skin, and to cause perspiration; while, on the other hand, it is objectionable in inflammatory cases. In chlorosis, morrhrea, dyspepsia, hysteria, scrofula, &c., it has also been found useful.

f. It has been applied to cancerous and other ulcers, to allay pain, to improve the quality of the secretions, and to check sloughing. It is usually administered by means of a tube connected with a bottle generating the gas. In this case it should be procured by the action of sulphuric acid on marble, for if hydrochloric acid be employed, gas requires washing, to remove any of this acid which may pass with it. Or it may be used in the form of solution, in which case bottle-soda-water may be employed. Or, lastly, we may apply the latter by poultice.

Administration.—Internally, carbonic acid may be administered in the form of carbonic acid water (the ordinary bottle-soda-water) which may be given in quantities regulated by the moderate desires of the patient.

When no objection exists to the use of the vegetable salts of potash, carbonic acid may be administered under the form of the ordinary effervescing draught, composed of a vegetable acid and an alkaline carbonate. In febrile disorders, when the stomach is in a very irritable condition, I prefer a draught made with citric acid and the bicarbonate of potash.

Another mode of employing carbonic acid is under the form of the carbonated mineral waters.
These are distinguished, according to the nature of their preponderating constituent, into the acidulo-alkaline (as those of Pougues, Vichy, Mont d'Or, Spa, Selters, Bilin, Altwasser, &c.), the acidulo-chalybeat (as those of Flinsberg, Giesshübel, Fachingen, and Pyrmont), and the acidulo-saline (as those of Wildungen, Kissingen, Schwalheim, &c.)

[For further information concerning the acidulous waters, consult Lee's Account of the Watering-Places of the Continent; and the article on mineral waters, by Dr. Thomson, in the Cyclopaedia of Medicine.]

ANTIDOTES.—In accidents arising from the inhalation of carbonic acid or carbonic oxide, proceed as follows:—remove the patient immediately into the open air, and place him on his back with his head somewhat elevated. Produce artificial respiration by pressing down the ribs, forcing up the diaphragm, and then suddenly removing the pressure. Dash cold water over the body, and abstract a small quantity of blood either by venesection or cupping. Stimulants of various kinds may be employed either internally by the stomach, or in the form of frictions, inhalations (as of ammonia, weak chlorine, &c.)

**Alcohol.**—**Alcohol.**

**History.**—Fermented liquors were known in the most remote ages of antiquity. The sacred historian tells us (Genesis, ch. ix.) that after the flood (which is supposed to have occurred 2,348 years before Christ), "Noah planted a vineyard; and he drank of the wine, and was drunken." Homer, the most ancient of all the profane writers, and who lived more than 900 years before the Christian era, also frequently mentions wine and notices its effects on the body, mind, &c. (Odyssey, ix. and x.)

Herodotus (Euterpe, lxvii.), who wrote 445 years before Christ, tells that the Egyptians drank a liquor fermented from barley.

It is uncertain at what period vinous liquors were first submitted to distillation. Morewood (Essay on Inebriating Liquors, p. 107) considers the Chinese to have been acquainted with this process long before the rest of Asia, Africa, and Europe. It is usually stated that Albuca, who is supposed to have lived in the 12th century, taught the mode of procuring spirit from wine (Gmelin, Handbuch d. Chemie, Bd. 2, p. 27).

Raymond Lully in the 13th century was acquainted with spirit, well as with the mode of depriving it of water by means of carbonate of potash.

**Preparation.**—The preparation of alcohol may be divided into three stages: the production of a fermented vinous liquid; the preparation of this of an ardent spirit by distillation; and, lastly, rectification or purification.

**Stage 1. Production of a Vinous Liquor.**—When vegetable substances are placed in contact with air and moisture, they undergo that kind of decomposition which is denominated fermentation. Products of this process vary at different periods or stages; and one depends the distinction into kinds or varieties of fermentation. Starchy liquids, under some circumstances, become saccharine; the process being termed the saccharine fermentation. Sugar dissolved in water, and mixed with glutinous matter, is converted into carbonic acid and alcohol; and to this process the name of vinous fermentation is applied. Vinous liquids are capable of generating acetic acid, and the process is denominated acetous fermentation. Lastly, most veget...
SUBSTANCES are slowly converted into gases and a substance called vegetable mould (humus), constituting the process called the putrefactive fermentation.

To produce a vinous liquid it is necessary that there be present sugar, some substance capable of forming sugar, as starch), a certain quantity of water, and a ferment (usually yeast). Moreover a certain temperature (the best is between 70° and 80° F.) is necessary. The precise actions which each of these essentials performs are not known. As Celsius has remarked, the changes may depend on the development of forces of no common nature. The products of this process are carbonic acid, alcohol, and yeast. To account for the two first of these we take the data furnished us by Thenard.

<table>
<thead>
<tr>
<th>Substances fermented at 59°</th>
<th>Products of fermentation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol 0.822</td>
<td>171.5</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>94.6</td>
</tr>
<tr>
<td>Nauseous residue</td>
<td>12.0</td>
</tr>
<tr>
<td>Residual yeast</td>
<td>40.0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loss</td>
</tr>
<tr>
<td></td>
<td>41.9</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>360.0</td>
</tr>
</tbody>
</table>

Now the nauseous residue and residual yeast nearly make up the quantity of yeast employed; and supposing the loss to be proportionally divided between the alcohol and the acid, it follows that, by the vinous fermentation, sugar is resolved into carbonic acid and alcohol.

The explanation of the changes which occur in the conversion of chararine solutions into alcholic liquors, depends, of course, on the view of the composition of sugar. If we adopt, with Mr. Brande (Manual of Chemistry), 162 as the equivalent for sugar, the following are the changes:—One equivalent or 162 parts of sugar, with two equivalents or parts of water, are converted into four equivalents or 88 parts of carbonic acid, and four equivalents or 92 parts of alcohol.

<table>
<thead>
<tr>
<th>Substances used.</th>
<th>Results.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>4 eq. Carbon</td>
<td>24</td>
</tr>
<tr>
<td>8 eq. Carbon</td>
<td>48</td>
</tr>
<tr>
<td>8 eq. Oxygen</td>
<td>64</td>
</tr>
<tr>
<td>2 eq. Oxygen</td>
<td>16</td>
</tr>
<tr>
<td>10 eq. Hydrogen</td>
<td>10</td>
</tr>
<tr>
<td>2 eq. Oxygen</td>
<td>16</td>
</tr>
<tr>
<td>2 eq. Hydrogen</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4 eq. Alcohol 92</td>
</tr>
</tbody>
</table>

The liquid obtained by the vinous fermentation has received different names, according to the substance from which it is obtained. When cured from the expressed juices of fruits, as grapes, currants, gooseberries, &c., it is denominated wine (vinum); from a decoction of malt or hops, ale or beer (cerevisia); and from honey and water, mead (drométi). Fermented infusions of barley (raw grain and malt) procured by the distillers of this country for the production of ardent spirit, technically denominated washes.

The liquid obtained by the vinous fermentation consists of water, alcohol, colouring and extractive matters, volatile oil, various acids and gums.

Stage 2. Production of Ardent Spirit.—By the distillation of a vinous liquid we obtain ardent spirit (spiritus ardens). When this is employed, the spirit is called brandy (spiritus vini gallicii); when
the vinous liquid is obtained by the fermentation of molasses or treacle. The spirit is termed rum (spiritus sacchari); when the liquid is a fermented infusion of grain (wash), the spirit is denominated corn spirit (spiritus frumenti); and when the vinous liquid is either a fermented infusion of rice or toddy (palm wine), the spirit is named arrack (if from the former, it is termed spiritus oryzae). The well-known liquors called gin, holland or geneva, and whiskey, are corn spirits flavoured.

Ardent spirit, from whatever source obtained, consists of water, alcohol, volatile oil, and, frequently, colouring matter. The following are, according to Mr. Brande (Phil. Trans. for 1811 & 1813), the average quantities of alcohol (sp. gr. 0.825 at 60° F.) in some kinds of ardent spirit:

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>Alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 parts (by measure) of</td>
<td>100 parts (by measure) of</td>
</tr>
<tr>
<td>Brandy contain</td>
<td>Whiskey (Scotch) contain</td>
</tr>
<tr>
<td>Rum</td>
<td>Whiskey (Irish)</td>
</tr>
<tr>
<td>Gin</td>
<td></td>
</tr>
</tbody>
</table>

When wash is distilled, the fluid that comes over is called singlings, or low wines. It is concentrated or doubled by a second distillation, by which raw corn spirit is obtained. Towards the end of the distillation, the distilled product acquires an unpleasant odour and taste from the presence of volatile oil, and is called faints. Raw corn spirit is sold by the distiller to the rectifier at 11 or 25 per cent. over proof, in the language of Sykes' hydrometer.

**Stage 3. Rectification.**—The object of the rectifier is to deprive ardent spirit of its volatile oil and water. This is effected by repeated distillations, and by the use of pearlash (carbonate of potash) which, by its powerful affinity for water, checks the rise of this fluid distillation.

All kinds of ardent spirits contain a volatile oil, which is termed the Germans Fuselöl. That obtained from potato spirit has been described by Pelletan (Jour. de Chimie Médicale, tom. 1st. p. 76), and the name of huile volatile de pomme-de-terre: it appears to be analogous to the oil procured from corn spirit, and which has been noticed by Buchner (Repert. 24, 270). From Messrs. Bowerbank, rectifiers, London, I have received, under the name of oil of grain, a sample of volatile oil obtained by them in the rectification of corn spirit. It is limpid, transparent liquid, of a pale yellow colour, having an unpleasant odour and an acrid taste. When washed with water, and then distilled from chloride of calcium, it is quite colourless. Its sp. gr. is 0.833 at 56° F. It burns in the atmosphere with a flame like that of light carburetted hydrogen gas. It dissolves iodine, and is soluble in alcohol and ether, but is insoluble in water, in liquor ammonia, and in liquor potassa. It dissolves in strong nitric acid, but acquires a slightly yellowish tinge, and when the mixture is heated, violent re-action takes place. Nitrous fumes mixed with nitric ether are so rapidly evolved, that if the experiment be performed in a tubulated retort the stopper is sometimes forced out with considerable violence. Sulphuric acid added to this forms with it a deep, blood-red coloured, thick liquid, and evolves heat and an odour analogous to that of mint. Potassium rapidly decomposes it with the evolution of hydrogen. I am informed by Messrs. Bowerbank that they obtain from 500 gallons of corn spirit about 1 gallon of oil grain, which they employ as a substitute for lamp oil.
In the London Pharmacopœia alcohol is directed to be procured by dissolving one pound of chloride of calcium (fused) in a gallon of rectified spirit (sp. gr. 0.838); from this seven pints and five fluid ounces of alcohol (sp. gr. 0.815) are to be distilled. In this process the chloride of calcium, (which is very soluble in spirit) having a powerful affinity for water, prevents the rise of this fluid during distillation, and thus the spirit is deprived of nearly the whole of its water.

Properties.—Alcohol is a limpid, colourless, inflammable liquid, having a peculiar and penetrating odour, and a burning taste. Its sp. gr. at 150 F., is 0.7947; at 62½ F., 0.791; at 173° F., it is only 0.73869 (Dumas, Traité de Chimie, t. 5, 462).

No means of solidifying it are at present known. It boils at 173° F.: every volume of the boiling liquid gives 488:3 vols. of vapour calculated 212° F. The sp. gr. of alcohol vapour by experiment is 1'6133, by calculation; according to Dr. Thomson, 1'5972.

It is very combustible. In atmospheric air it burns with a pale blue flame, giving out a very intense heat, and generating carbonic acid and water, but depositing no soot. The colour of the flame may be variously produced—as yellow by chloride of sodium, violet by chloride of potassium, green by boracic acid or a cupreous salt, carmine red by chloride of bismuth, crimson by chloride of strontium, and greenish yellow by chloride of barium. One volume of alcohol vapour requires, for its complete combustion, three volumes of oxygen gas, and yields two volumes of carbonic acid gas and three volumes of aqueous vapour. If alcohol vapour mixed with atmospheric air or oxygen gas be passed through a tube heated to dull redness, the products are carbonic, acetic, and aldehydic* acids, water, and a peculiar substance having a disagreeable, pungent smell (Liebig). By the combustion of alcohol vapour by spongy platinum the products are aldehydt, acetal, acetic acid, and acetic ether (Liebig).

Alcohol has a strong affinity for water: hence it abstracts this fluid from the atmosphere, and precipitates from their watery solution those salts (e. g. sulphate of potash) which are not soluble in spirit: while, on the other hand, water precipitates from their alcoholic solution those substances (e. g. resin and oil) not soluble in water. By the mixture of alcohol and water, heat is evolved, while air-bubbles are so copiously developed, that for a few moments the liquid appears turbid. When cold, the resulting compound is found to possess a greater density than the mean of its constituents: but as the condensation varies with the proportions of alcohol and water employed, the sp. gr. of the resulting compound can be ascertained by experiment only. The maximum condensation is obtained by mixing 54 vols. of alcohol with 49'77 vols. of water: the resulting compound measures 100 vols., so that the condensa-

* Aldehydic acid (Aldehydsäure) is a term applied by Liebig and Poggendorf (Handwörterbuch der Chemie) to the Lactic acid of Daniell. It is derived from alcohol de hydrogenatus. Its probable formula is C₄ H₂ O₂ + H₂.

† Aldehyde (Aldehyd), another term introduced by the same chemists to indicate a fluid composed of C₄ H₂ O₂.
tion is 3:77. If we regard this as a definite compound of alcohol and water, its composition may thus be stated:—

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Vols.</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>1</td>
<td>23</td>
<td>46</td>
<td>54·00</td>
<td>42·75</td>
</tr>
<tr>
<td>Water</td>
<td>3</td>
<td>27</td>
<td>54</td>
<td>49·77</td>
<td>49·69</td>
</tr>
</tbody>
</table>

Terhydrate of Alcohol | 1 | 50 | 100 | 100·00 | 92·8 |

Alcohol combines with certain salts (as the chlorides and nitrates) to form definite compounds, which have been termed *alcohates*, in which the alcohol appears to act as a substitute for the water of crystallization.

Alcohol is a solvent of many organic substances, as volatile oil, fixed oil, resin, extractive, most varieties of sugar, many nitrogenous organic acids, the vegetable alkalies, urea, caseum, gliadine, leucine, picrome, and osmazome. It prevents the putrefaction of animal substances, and is, in consequence, extensively employed in the preservation of anatomic preparations. Its efficacy is imperfectly understood. It acts, in part at least, by excluding air (oxygen) and water,—the two powerful promoters of putrefaction; for when animal substances are immersed in spirit, the fluid mixes with and replaces the water with which the tissue was inpregnated; and thus prevents putrefaction by removing one of the essential conditions to its production, namely, the presence of water. Its attraction for water, and its power of coagulating albuminous substances, are properties which probably assist powerfully in rendering it an antiseptic. Alcohol and rectified spirit of wine give greater firmness to, and whiten the animal tissues. The latter property is objectionable in the preservation of some morbid specimens, as gelatiniform cancer (cancer gelatiniforme or aréolaire of Cruveilhier,—the *matière colloïd* of Laennec. A mixture of one part rectified spirit and three parts water will, however, preserve specimens of the last-mentioned disease in a transparent condition.

**Characteristics.**—Alcohol and ardent spirits are recognized by their inflammability, odour, taste, and miscibility with water. In order to detect alcohol in liquids supposed to contain it, let the suspect liquor be submitted to distillation with a gentle heat (as from a vapor or water bath), and to the distilled liquid add dry carbonate of potash to abstract the water. The alcohol floats on the surface of the alkaline solution, and may be recognized by the characters above mentioned.

**Composition.**—The elementary constituents of alcohol are carbon, hydrogen, and oxygen.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>2</td>
<td>12</td>
<td>52·18</td>
<td>51·98</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>52·37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td>3</td>
<td>3</td>
<td>13·04</td>
<td>13·70</td>
<td>0·85</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13·31</td>
<td></td>
<td>0·84</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>34·78</td>
<td>34·61</td>
<td>0·55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>34·65</td>
<td></td>
<td>0·53</td>
</tr>
<tr>
<td>Alcohol</td>
<td>1</td>
<td>23</td>
<td>100·00</td>
<td>100·29</td>
<td>1·59</td>
</tr>
</tbody>
</table>

Chemists are not agreed as to the manner in which these constituents are grouped. By some these elements are regarded as forming one equivalent of olefiant gas, and one equivalent of water: others consider alcohol to be a compound of one equivalent of a $\frac{1}{2}$ carbo-hydrogen (called by some *etherine*, by others *tetarto-carbo-hydrogen* or *quadri-hydrocarburn*) and two equivalents of water; while a third class of philosophers vie
as liquid as a hydrated oxide of a \( \frac{1}{2} \) carbo-hydrogen (etherum of Kane, nitre of Berzelius), or as the hydrate of ether; for ether is by them garded as the oxide of etherum. The latter opinions involve the necessity of assuming the equivalent for alcohol to be 46; that is, double an amount stated above. The following table illustrates the views just
ted:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>1.14... 60°</td>
<td>Etherine</td>
<td>1.28...</td>
<td>60°</td>
<td>Ethereum</td>
<td>1.29...</td>
<td>60°</td>
</tr>
<tr>
<td>1.9</td>
<td>39°3</td>
<td>Water</td>
<td>2.15...</td>
<td>39°3</td>
<td>Oxygen</td>
<td>1.8...</td>
<td>39°3</td>
</tr>
<tr>
<td>Alcohol</td>
<td>1.46...</td>
<td>100°</td>
<td>Alcohol</td>
<td>1.46...</td>
<td>93°9</td>
<td>Alcohol</td>
<td>1.46...</td>
</tr>
</tbody>
</table>

**Alcoholometry.**—The value of ardent spirit is, of course, propor-
nate to the quantity of alcohol contained therein; and, therefore, a
udy mode of estimating this is most desirable. The alcoholometrical
ethod usually adopted consists in determining the sp. gr. of the liquid
an instrument called the hydrometer. That employed in this country,
 the collection of the duties on spirits, is called **Sykes's hydrometer.**
pirit having the sp. gr. 0.920, at 60° F. is called **proof spirit**; that
ich is heavier is said to be **under proof**, while that which is lighter is
called **over proof**. The origin of these terms is as follows:—Formerly a
ry rude mode of ascertaining the strength of spirit was practised, called the **proof**; the spirit was poured upon gunpowder, in a dish, and
amed. If at the end of the combustion the gunpowder took fire, the
pirit was said to be **above or over proof**; but if the spirit contained
uch water, the powder was rendered so moist that it did not take
; in this case the spirit was declared to be **below or under proof**.
pirit of different strengths will or will not inflame gunpowder,
ording to the quantity of spirit employed, it became necessary to fix
legal value of proof spirit: this has been done, and proof spirit
**spiritus tenuior**, Ph. L.) is defined, by act of parliament, to be such that
the temperature of 51° F. thirteen volumes of it weigh exactly as
uch as twelve volumes of water. According to this definition the
. at 60° F. is 0.920, and spirit of this strength consists of

<table>
<thead>
<tr>
<th>By Weight.</th>
<th>Sp. Gr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol. ...</td>
<td>49 ...</td>
</tr>
<tr>
<td>Water...</td>
<td>51 ...</td>
</tr>
<tr>
<td>Proof spirit...</td>
<td>100 ...</td>
</tr>
</tbody>
</table>

Proof spirit may be prepared by adding three pints of distilled water, at
, to five pints of rectified spirit, sp. gr. 0.838. Compounded spirits
y. gin) are not allowed (6 Geo. 4, cap. 80, sect. 124) to be kept or
out stronger than 17 per cent. under proof; but gin, as usually
ed by the rectifier, is 22 per cent. under proof. Distillers are not
mitted (6 Geo. 4, cap. 80, sect. 81) to send out spirits at any other
gh than 25 or 11 per cent. above, or 10 per cent. below proof.
legislature (6 Geo. 4, cap. 80, sects. 101 & 114) has also defined
rits of wine to be of the strength of 43 per cent. over proof at
least. The liquid sold as rectified spirit has usually a sp. gr. of
54 to 60 or 64 per cent. over proof. Hatters employ that at 54
56; varnish-makers that at 58 per cent. over proof. Rum and
indy, as usually sold, are 10 per cent. under proof. The act
already quoted (sect. 130) declares, that no foreign or colonial spirit (not being compounded colonial spirits) shall be kept or sent out of less strength than 17 per cent. under proof. The following table, showing the specific gravities of spirits of various strengths, indicated by Sykes’s hydrometer at 60° F., has been drawn up from "The Ne Plus Ultra (vol. ii.) of Assaying, Weighing, Measuring, and Valuing of Spirituous Liquors. By W. Gutteridge. London, 1828."

<table>
<thead>
<tr>
<th>Sykes’s Hydrometer.</th>
<th>Sp. Gr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 per centum</td>
<td>0·8095</td>
</tr>
<tr>
<td>64</td>
<td>0·8221</td>
</tr>
<tr>
<td>62</td>
<td>0·8259</td>
</tr>
<tr>
<td>60</td>
<td>0·8298</td>
</tr>
<tr>
<td>58</td>
<td>0·8336</td>
</tr>
<tr>
<td>56</td>
<td>0·8376</td>
</tr>
<tr>
<td>55·9</td>
<td>0·8379</td>
</tr>
<tr>
<td>55·7</td>
<td>0·8383</td>
</tr>
<tr>
<td>54·1</td>
<td>0·8413</td>
</tr>
<tr>
<td>50·1</td>
<td>0·8482</td>
</tr>
<tr>
<td>43·1</td>
<td>0·8597</td>
</tr>
<tr>
<td>25</td>
<td>0·8869</td>
</tr>
<tr>
<td>11·1</td>
<td>0·9060</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sykes’s Hydrometer.</th>
<th>Sp. Gr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proof</td>
<td>0·9200</td>
</tr>
<tr>
<td>5 per centum</td>
<td>0·9259</td>
</tr>
<tr>
<td>10</td>
<td>0·9318</td>
</tr>
<tr>
<td>11</td>
<td>0·9329</td>
</tr>
<tr>
<td>17·1</td>
<td>0·9396</td>
</tr>
<tr>
<td>22·3</td>
<td>0·9448</td>
</tr>
<tr>
<td>23·1</td>
<td>0·9456</td>
</tr>
<tr>
<td>25·1</td>
<td>0·9476</td>
</tr>
<tr>
<td>50·3</td>
<td>0·9673</td>
</tr>
<tr>
<td>80·4</td>
<td>0·9854</td>
</tr>
<tr>
<td>100 (water)</td>
<td>1·0000</td>
</tr>
</tbody>
</table>

Another mode of judging of the strength of spirits (as brandy) is the phial test, technically called the bead, the prenne d’Hollande of the French. It consists in shaking the spirit in a phial, and observing the size, number, and bursting of the bubbles (or beads as they are termed) the larger and more numerous the beads, as well as the more quickl they break, the stronger the spirit.

Hitherto chemical analysis has been of little avail in determining the strength of spirit, at least for commercial purposes. For, on the one hand, we are yet in want of an accurate method of determining the relative quantities of alcohol and water in mixtures of these fluids; while, on the other, the combustion of spirit by the black oxide of copper, and the estimation of the quantity of alcohol by the carbonic acid produced, is impracticable for ordinary purposes.

Purity.—Alcohol, or rectified spirit of wine, should be colourless and transparent. Its freedom from other substances than alcohol or water is to be determined by the purity of its odour, by the absence of any acid or alkaline reaction, by its easy and complete volatility. The presence of volatile oil (oil of grain, or Fuselol of the Germans) may be ascertained by strong sulphuric acid, which communicates a red colour to this substance (Geiger, Handb. d. Pharm.) Vogel says, that a solution of silver is a delicate test of volatile oil: when mixed with spirit, and exposed to solar light, it becomes red if any oil be present, but undergoes no change of colour if the spirit be pure.

Physiological Effects. (a.) On vegetables.—Alcohol acts on plant as a rapid and fatal poison. Its effects are analogous to those of hydrocyanic acid.

(b.) On animals.—Leeches immersed in spirit die in two or three minutes. Their bodies are shrivelled or contracted, and before death they make but few movements; the head and tail of the animal are drawn together. Fontana found, that when half the body of a leech was plunged in spirit, this part lost all motion, whilst the other half continued in action. The same experimentalist observed, that spirit killed frogs when administered by the stomach (in doses of 40 drops), injected
neath the skin, or when applied to the brain or spinal marrow. Plunging the heart of this animal in spirit caused its motion to cease in twenty seconds. Applied to the right crural nerve of a frog, it destroyed the will of moving, in the right foot, on the application of stimulus (Fontana, *eatise on the Venom of the Viper*, translated by J. Skinner, vol. ii. 371, *et. seq.*). Monro (*Essays and Observ. Physic. and Literary, i. iii. p. 340*) observed, that alcohol applied to the hind legs of a frog rendered the pulsations of the heart less frequent, and diminished sensibility and mobility. Fontana (*op. cit. p. 365, *et. seq.*) states that turtles are killed by spirit administered by the stomach or by the anus, or ejected beneath the skin: before death the animal became motionless: applied to the heart of these animals it destroyed the contractility of this organ. Some very interesting experiments were made with spirit on animals by Flourens (*Recherches sur les fonctions et les propriétés du système nerveux dans les animaux vertébrés*, 1824). This distinguished physiologist administered six drops of alcohol to a sparrow, whose skull he had bare. In a few minutes the animal began to be unsteady both in walking and flying. After some time a dark-red spot appeared on the tail, in the region of the cerebellum, and became larger and deeper in proportion as the alcohol more powerfully affected the animal. Some other experiments, Flourens observed that alcohol produced the same effects on the movements of birds as the removal of the cerebellumasonned, but that when alcohol was administered the animal lost the use of his senses and intellectual faculties; whereas when the cerebellum was removed, no alcohol being given, he preserved them. From these and other observations, Flourens is of opinion that alcohol, in a certain dose, acts specifically on the cerebellum, and that in larger doses it affects other parts also. Furthermore, he thinks the physical action of alcohol on the cerebellum to be absolutely the same as a mechanical lesion. The effect of alcohol on fishes is analogous to that on other animals. A little spirit be added to water in which are contained some minnows *phoxinus, Linn.*), the little animals make a few (spasmodic?) spasms, and become incapable of retaining their proper position in the water, but float on their sides or back. If removed into pure water they recover. The mammals on which the effects of alcohol have been tried are dogs, horses, rabbits, and guinea-pigs. The principal experimentalists Courten (*Phl. Trans. for 1712*); Fontana (*op. cit.*); Viborg (*Abhandl. Thierärzte, Theil II.* quoted by Wibmer, *Die Wirkung, &c.*); Brodie (*il. Trans. for 1811*); and Orfila (*Toxicologie Générale*). The results of these experiments may be thus briefly expressed:—Four drachms of alcohol injected into the jugular vein of a dog coagulated the blood and the instant death (Orfila). Introduced into the stomach of cats, dogs, rabbits, it produces an apoplectic condition (Brodie and Orfila): this is preceded, according to Orfila, by a strong excitement of the mind. The same experimentalist found that alcohol acts with less energy when injected into the cellular texture, than when introduced into the stomach; from which he infers that its first effects are the result of action which it exerts on the extremities of the nerves; though he admits that ultimately it becomes absorbed. On examining the bodies of animals killed by introducing alcohol into the stomach, this viscus has been found in a state of inflammation.
(c.) On man.—The effects of alcoholic liquors on man vary with the strength of the liquid, the substances with which the alcohol is combined, the quantity taken, and the constitution of the patient.

a. The local effects of alcohol and rectified spirits are those of powerfully irritant and caustic poison. To whatever part of the body these agents are applied they cause contraction and condensation of the tissue, and give rise to pain, heat, redness, and other symptoms of inflammation. These effects depend partially or wholly on the chemical influence of alcohol over the constituents of the tissues: for the affinity of this liquid for water causes it to abstract the latter from soft living parts with which alcohol is placed in contact; and when these are of an albuminous or fibrinous nature, it coagulates the liquid albumen or fibrin, and increases the density and firmness of the solid albumen or fibrin. The irritation and inflammation set up in parts to which alcohol is applied depends (in part) on the resistance which the living tissue makes to the chemical influence of the poison; in other words, it is the reaction of the vital powers, brought about by the chemical action of alcohol. But besides the local influence of this liquid dependent on its affinity, we can hardly refuse to admit a dynamical action (vide pp. 7, 11), in virtue of which it sets up local irritation and inflammation, independent of its chemical agency. The coagulation of the blood contained in the vessels of the part to which this liquid is applied (an effect which Orfila observed when he killed an animal by injecting alcohol into the ecellular tissue of the thigh of a dog), depends of course on the chemical influence of the poison.

β. The remote effects of ardent spirits on man may be conveniently considered in the order of their intensity; and for this purpose we may divide them into three degrees or stages.

1. First or mildest degree (Excitement).—This is characterized by the excitement of the vascular and nervous systems: the pulse is increased in frequency, the face flushed, the eyes animated and perhaps red, the intellectual functions are powerfully excited, the individual is not disposed to joy and pleasure; cares disappear; the ideas flow more easily and are more brilliant. At this period the most violent protestations of love and friendship are frequently made, there is a strong disposition to talk, and various indiscretions are oftentimes committed. This degree of effect I presume to be the condition to which all persons aspire in drinking: the unfortunate drinks to drown his cares; the coward to give him courage; the bon-vivant for the sake of enjoying the society of his friends; the drunkard from mere sensuality. Nor perhaps, would wish to go beyond this, yet many, when they have gone thus far, exceed their intended limit.

2. Second degree (Intoxication or Drunkenness).—The essential characters of this stage are a disordered condition of the intellectual functions and of volition, manifested by delirium, varying in its character in different individuals, and by an incapability of governing the acts of the voluntary muscles. This state is accompanied with excitement of the vascular system, and frequently with nausea and vomiting: it is followed by an almost irresistible desire for sleep, which usually continues for several hours, and is attended with copious perspiration. When the patient awakes he complains of headache, loathing of food, great thirst, and lassitude: the tongue is furred and the mouth clammy.
3. Third degree (Coma or True Apoplexy).—This condition is usually served when excessive quantities of spirit have been swallowed in a short time. According to Dr. Ogston (quoted by Dr. Christison) the patient is sometimes capable of being roused; the pulse is generally slow, the pupils are occasionally contracted, but more commonly dilated, and the breathing is for the most part slow: but exceptions exist to all these statements. Convulsions are rare; when they occur the patients are usually young. In some cases actual apoplexy (with or without agnose extravasation) is brought on. The immediate cause of death appears to be either paralysis of the muscles of respiration, or closure of the glottis.—(Vide pp. 68 and 69).

Consequences of Habitual Drunkenness.—The continued use of spirituous liquors gives rise to various morbid conditions of system, a few of the most remarkable of which can be here referred to. One disease is known by the various names of delirium tremens, potatorum, oinomania, &c., and which is characterized by delirium, mor of the extremities, watchfulness, and great frequency of pulse. This pathology is not understood. It is sometimes, but not constantly, met with, or dependent on, an inflammatory condition of the brain and its membranes. Opium has been found an important agent in exciting the subsidence of this affection.

Insanity is another disease produced by the immoderate and habitual use of spirituous liquors. The records of our pauper lunatic asylums show that, in a large proportion of cases, the exciting cause of madness is the use of ardent spirits.

Disease of the liver is frequently met with in drunkards. It is generally of the kind termed by Baillie common tubercle of the liver, by Elliotson (Med. Gaz. vol. xii. p. 484) the gin liver; by others, lobulated, mamellated, or scirrhous liver. Laennec calls it nosis (from ἄψης, yellowish), in reference to its usual tawny yellow tawny. A beautiful representation of it is given by Cruveilhier (Anatom. Patholog. liv. 12th. pl. 1.) Dr. Carswell (Patholog. Anat. art. Atrophy) described it as consisting in atrophy of the lobular structure of the liver produced by the presence of a contractile fibrous tissue. It is not, therefore, a disease depending on the formation of a new tissue. The biliary ducts, which so frequently accompanies it, arises from the compression which the portal vessels are subjected by the fibrous tissue; and the jaundice, another frequent effect of it, doubtless depends on compression of the gall ducts. Some excellent remarks on this disease have been made by my able colleague, Dr. Hope (Principles and Illustrations of Human Anatomy.)

Persons addicted to the use of ardent spirits are usually dyspeptic. Chronic inflammation of the stomach, or even a scirrhous state of the anus, has been said to be occasionally produced by hard drinking. The kidneys of dram-drinkers are sometimes affected with a disease described by Dr. Bright, and which is generally attended by albuminous urine. They assume a granular state, which Dr. Hope regards as corresponding to the granular liver just described.

Modus Operandi.—That alcohol becomes absorbed is proved by the fact that it has been found in the blood. Tiedemann and Gmelin (Über Wege auf welchen Substanzen aus d. Magen ins Blut gelangen) recognized the odour of it in the blood of the splenic vein, though they
were unable to detect it in the chyle. A similar observation is reported by Magendie (Element. Compend. of Physiology, by Dr. Milligan, p. 2, 1823). Moreover the recognition of the odour of alcoholic liquors in the breath of individuals who have swallowed them, as well as their detection by their smell in the fluid contained in the ventricles of the brain, in the pericardium, &c., prove indisputably that alcohol becomes absorbed. Dr. Cooke (Treatise on Nervous Diseases, i. 222) states, on the authority of Sir A. Carlisle, that in one case the fluid of the ventricles of the brain had the smell, taste, and inflammability of gin. The correctness of the last observation has been questioned by Dr. Christison, on the ground that gin of sufficient strength to take fire could not enter the blood vessels without coagulating the blood.

MORbid Appearances.—On examining the bodies of individuals who have been poisoned by ardent spirits, redness and inflammation of the stomach are sometimes, but not invariably found. In old drunkards the mucous membrane of the stomach is often injected and thickened. Consideration of the cerebral vessels, with or without extravasation of blood, effusion of serum, is not unfrequently observed. Traces of the poison may or may not be found in the stomach, according to the rapidity with which death has been produced. The odour of the spirit may perhaps be recognised in various parts of the bodies, especially in the brain and the serous cavities.

Uses.—1. Medicinal. (a.) Internal.—Raw spirit is rarely administered internally: for when ardent spirit is indicated, brandy, rum, gin, or whiskey, is usually employed. Each of these liquors presents some peculiarity of operation which makes it preferable in certain cases. "Brandy," observes Dr. Paris (Pharmacologia), "is said to be simply cardiac and stomachic; rum, heating and sudorific; gin and whiskey, diuretic; and arrack, heating and narcotic." As a stomachic stimulant, brandy is employed to relieve spasmodic pains, to check vomiting, especially sea-sickness, and to give temporary relief in some cases of indigestion attended with pain after taking food. As a stimulant and restorative the last stage of fever, brandy is sometimes given with considerate benefit. For this purpose the mistura spiritus vini gallici of the London Pharmacoeopia, better known as egg flip, is said to be a favourite preparation with Sir H. Halford. To relieve mild cases of diarrhoea, attended with griping pain, but unaccompanied by any inflammatory symptoms, a small quantity of brandy and water, taken warm with a megis, is often an efficacious remedy. As a powerful stimulant, to support the vital powers, and to prevent fainting during a tedious operation, brandy is most serviceable. It is also used to relieve syncope, and restore patients from a state of suspended animation. In delirium tremens it is not always advisable to leave off the employment of spiritualuous liquor at once, since the sudden withdrawal of the long-acquainted stimulants may be attended with fatal consequences. In poisoning by foxtail brandy and ammonia are the remedies most to be relied on.

(b.) External.—Spirit of wine is used externally for several purposes, of which the following are the principal:—As a styptic, to strain hemorrhage from weak and relaxed parts. It is efficacious in various ways: it coagulates the blood by its chemical influence on the liquid albumen and fibrin, and it causes the contraction of the mouths of bleeding vessels by its stimulant and astringent qualities. Sponge
of linen soaked in brandy, or in spirit and water, has been applied to the mouth of the uterus in uterine hæmorrhage (Richter, Arzneimittelehre, 3rd Bd. S. 256). Spirit is used to harden the cuticle over tender and delicate parts. Thus brandy is sometimes applied to the nipples several weeks before delivery, in order to prevent production of sore nipple from suckling, in individuals predisposed to it. The efficacy of spirit, in hardening the cuticle, depends, in part, on its chemical influence. Spirit gargles have been found serviceable in checking the tendency to inflammation and swelling of the tonsils. As a stimulant application, warm rectified spirit has been applied to burned or scalded parts, on the principles laid down for the treatment of these cases by Dr. Kentish. Properly diluted, spirit has been employed as a wash in various skin diseases, and in ulcers of bed-ridden persons, and as a collyrium in chronic ophthalmia. Frictions with rectified spirits have been used in the abdominal region, to promote labour pains; on the chest, to excite the action of the heart, in fainting or suspended animation; in the hypogastric region, to stimulate the bladder, when retention of urine depends on inertia, or a paralytic condition of this viscus; in various parts of the body, to relieve the pain arising from bruises, or to stimulate paralyzed parts.

The inhalation of the vapour of rectified spirit has been recommended to relieve the irritation produced by the inspiration of chlorine; but I have tried the practice on myself without benefit. The readiest mode of effecting it is to drop some spirit on a lump of sugar, and hold this in the mouth during inspiration.

Diluted spirit has been used as an injection for the radical cure of phariocele. A mixture of wine and water, however, is commonly employed in this country.

Spirit has been used to form cold lotions. — As the efficacy of it depends on its evaporation, it should be applied by means of a single yard of linen, and not by a compress. Evaporating lotions are applied to the head in cephalalgia, in phrenitis, in fever, in poisoning by opium, &c., to fractures of the extremities; to parts affected with erysipelas, inflammation, &c.

2. Pharmacutical.—The alcohol of the Pharmacopoeia (sp. gr. 0.815) is not employed in the preparation of any officinal substances, it is a valuable agent in chemical analysis, and is used in determining the purity of certain medicinal substances; as iodine, iodide of potassium, vegetable alkalies, castor oil, &c. Rectified and proof spirits are the most extensively employed in officinal pharmacy: as in the formation of tinctures (the alcoolès of the French pharmacologists), spirits (alcoolats alcoolata of the Codex), ethers, ethereal oil, and resinous extracts, and in the manufacture of the vegetable alkalies. Spirit is added to various preparations to assist in preserving them.

Antidotes. — The first object in the treatment of poisoning by irrititious liquors is to evacuate the contents of the stomach, which is best effected by the stomach-pump; emetics being frequently unsuccessful. Stimulants are then to be employed: the most effectual are the injection of cold water into the ears, cold affusion to the head and neck, warmth to the extremities, when those are cold, and the internal use either of ammonia, or of the solution of the acetate of ammonia, both of which
agents have been found useful in relieving stupor. The cerebral con-
gestion often requires the cautious employment of local blood-letting
and the application of cold to the head. If the patient appear to be
dying from paralysis of the respiratory muscles, artificial respiration
should be effected: if from closure of the larynx, tracheotomy may be
performed (see pp. 68 and 69).

Æther Sulphur'ricus.—Sulphur'ic E'ther.

History and Synonymes.—This liquid is said to have been known
to Raymond Lully, who lived in the 13th century, and to Basil Valentine
in the 15th century. In 1540, Valerius Cordus described the method
making it. He termed it oleum vitrioli dulce. The Germans call
vitriolic naphtha (naphtha vitrioli).

Natural History.—It is always an artificial product.

Preparation.—The following are the directions in the London Pha-
macopeia for preparing it:—"Take of rectified spirit three pounds,
sulphuric acid two ounces, carbonate of potash, previously ignited, an
ounce: pour two pounds of the spirit into a glass retort, add the acid
to it, and mix. Afterwards place it on sand, and raise the heat so that the
liquor may quickly boil, and the ether pass into a receiving vessel cooled
with ice or water. Let the liquor distil until some heavier portion begins
to pass over. To the liquor which remains in the retort after the heat
has subsided, pour the remainder of the spirit, that ether may distil
in the same manner. Mix the distilled liquors, then pour off the super-
natant portion, and add to it the carbonate of potash, shaking them fre-
quently during an hour. Lastly, let the ether distil from a large retor,
and be kept in a stoppered vessel."

When required to be produced in small quantities, ether may be made
in a tubulated glass retort, connected by an adopter with a cooled glass
receiver; but on the large scale a leaden still heated by steam is used
instead of the retort. With this is connected a condensing worm, kept
cool in the usual way, and delivering the distilled liquor into a receiver with a glass lid.

Theory of Etherification.—In order to convert two equivalents
or 46 parts of alcohol into one equivalent or 37 parts of ether, we must
abstract one equivalent or nine parts of water.

<table>
<thead>
<tr>
<th>Carbon</th>
<th>Hydrogen</th>
<th>Oxygen</th>
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<tbody>
<tr>
<td>2 eq.</td>
<td>4 eq.</td>
<td>6 eq.</td>
</tr>
<tr>
<td>1 eq.</td>
<td>0 eq.</td>
<td>4 eq.</td>
</tr>
<tr>
<td>1 eq.</td>
<td>4 eq.</td>
<td>5 eq.</td>
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</table>

But though the phenomena are thus far very simple, there are some
accessory changes which make the theory of etherification exceeding
complicated, and about the precise nature of which chemists are not
quite agreed.

It appears that when strong liquid sulphuric acid and rectified spirit
are mixed, the acid loses part of its saturating power, and a new com-
 pound is formed (sulpho-vinic acid of Hennell; ethereo-sulphuric ac-
 of Liebig). The heat employed causes this to undergo decomposition,
which ether and sulphuric acid are obtained. Mr. Hennell explains the process in the following way:—Four equivalents or 196 parts of protohydrated sulphuric acid re-act on two equivalents or 46 parts of alcohol, and produce two equivalents or 18 parts of water, one equivalent, or 108 parts of sulpho-vinic acid, and two equivalents of 116 parts of the binhydrated sulphuric acid. These are the products of the first stage of the process. By the heat employed the sulphonylic acid is decomposed into one equivalent or 28 parts of a \( \frac{1}{2} \) carbo-hydrogen (etherine), and two equivalents or 80 parts of anhydrous phuric acid. The carbo-hydrogen (etherine) uniting with one equivalent of \( \frac{1}{2} \) water forms one equivalent or 37 parts of ether, which distil over; while the anhydrous sulphuric acid, with the binhydrated sulphuric acid, reproduces protohydrated sulphuric acid, which remains in the retort with one of the two equivalents of water formed in the first stage of the process; so that ether, water, and protohydrated sulphuric acid, are the products of the second stage of the process. The following diagram illustrates the changes according to Mr. Hennell’s views (Phil. Trans. 1826 and 1828):

**RESULTS.**

<table>
<thead>
<tr>
<th>DIESTS USED</th>
<th>FIRST STAGE</th>
<th>SECOND STAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 eq. Oxygen 16</td>
<td>2 eq. Water 18</td>
</tr>
<tr>
<td>Alcohol 46</td>
<td>2 eq. Hydrogen 2</td>
<td>1 eq. Water 9</td>
</tr>
<tr>
<td></td>
<td>1 eq. Sulphur, Ad. 108</td>
<td>2 eq. Sulphur, Ad. 80</td>
</tr>
</tbody>
</table>

According to this theory, sulphonylic acid may be regarded as a sulphate of etherine.

The theory of etherification, according to Liebig (Handwörterbuch der Chemie, 1 Bd. S. 110—116, 1837), may be thus concisely stated:—Two equivalents or 196 parts of the protohydrated sulphuric acid re-act on two equivalents or 46 parts of alcohol, and produce one equivalent of 9 parts of water, one equivalent of 117 parts of ethereo-sulphuric acid, and two equivalents of 116 parts of binhydrated sulphuric acid. These are the products of the first stage of the process. At a temperature of about 255° F. the ethereo-sulphuric acid is decomposed into an equivalent of 37 parts of ether, which distil over, and two equivalents or 80 parts of hydrons sulphuric acid, which, with the binhydrated sulphuric acid, produce four equivalents or 196 parts of the protosulphuric acid: the latter remain in the retort with the equivalent of water produced in the first stage of the process. The following diagram will perhaps serve to render this view more intelligible:
The ethero-sulphuric acid of Liebig may be viewed as the hydrate sulpho-vinic acid (Hennell)—as a bisulphate of ether,—as the hydrat bisulphate of etherine,—or, lastly, as the bisulphate of the oxide etherum (ethule).

The ethero-sulphuric acid of Liebig must not be confounded with compound of a similar name described by Magnus, and which contain according to Liebig (op. cit.), neither sulphuric acid nor ether, but consist of hyposulphuric acid and an organic substance (protoxide of etherine, and its elementary composition is probably $S\text{C}^4\text{H}^4\text{O}^6$.

During the distillation of ether, the relative proportions of the ingredients in the retort are constantly varying: the quantity of sulpho-vinic acid (ethero-sulphuric acid, according to Liebig) is diminishing, while that of sulphuric acid is increasing; and, consequently, during the progress of the process the boiling point of the liquid gradually rises. When it has arrived at about $340^\circ$ F., and when, consequently, the sulphuric acid is greatly in excess, the carbo-hydrogen and acid begin to react on each other; the products of this reaction are water, sulphuro acid, and carbon: the latter blackens the liquid in the retort, while the sulphurous acid is distilled over with some water. Hence, therefore, as soon as “a heavier portion” (i.e. an aqueous solution of sulphuric acid) is perceived under the ether in the receiver, the process is stopped and when the liquid in the retort has become sufficiently cool, more rectified spirit is added, and distillation again performed.

The rectification of ether is intended to free it from alcohol, water-sulphurous acid, and oil of wine. It is ordered to be effected by the addition of carbonate of potash and re-distillation. In order to separate the alcohol from ether, the readiest method is to shake the ether with twice its bulk of water; then pour it off, and remove the water which the washed ether has dissolved, by adding some fresh burned lime, and distilling the ether a second time.

Properties.—At ordinary temperatures ether is a colourless, very limpid liquid, having a penetrating, peculiar, though somewhat fragrant odour; a hot, pungent taste, and a high refractive power. It is a bad conductor of electricity. Absolutely pure ether has not been solidified by any degree of cold hitherto produced. The sp. gr. of pure ether at $68^\circ$ F. is, according to Dumas and Boulay, 0·713 (Brande’s Manual of Chemistry). The ether of the shops contains a little alcohol, at its sp. gr. varies from 0·733 to 0·765: in the Pharamacopia the sp. gr. at $62^\circ$ F. is fixed at 0·750. Ether is extremely volatile: when of sp.
209, its boiling point (the mercury in the barometer standing at 30 inches), is about 98° C. In a vacuum it boils at 40° F. below zero. The evaporation of ether causes intense cold. The sp. gr. of ether vapour is found by Gay-Lussac to be 2.586. Pure and recently prepared ether possesses neither acid nor alkaline properties; but, by exposure to air and light, it absorbs oxygen, by which acetic acid and water are produced. The acetic acid is not immediately observed, because it combines with some undecomposed ether to form acetic ether (Dumas).

Ether is very combustible: it burns in atmospheric air with a yellowish white flame, and forms carbonic acid and water. Its vapour, mixed with oxygen or atmospheric air, forms a violently explosive mixture. The house of an apothecary at Bern was blown up, in consequence of a lit candle being taken into a cellar in which a bottle of ether had been kept. One volume of ether vapour consumes, in burning, six volumes of oxygen gas: the products are four volumes of carbonic acid, and five volumes of aqueous vapour. By the slow combustion of ether vapour, means of a coil of platinum wire, a substance is formed which Daniell called lampic acid, but which he afterwards supposed to be acetic acid, combined with a peculiar compound of carbon and hydrogen. I have before mentioned, that it is called by Liebig, aldehydeic acid, who says it is composed of C\(^{1}\)H\(^{3}\)O\(^{2}\) + H (Handwörterbuch der Chemie, 1 Bd. S. 188, 1837).

Ether is sparingly soluble in water: nine volumes of the latter dissolve one of the former. Ether, which has been washed with water, contains a small portion of the latter liquid. Alcohol dissolves ether in all proportions.

Ether abstracts bichloride of mercury, terchloride of gold, and the quinchloride of iron, from their watery solutions. It readily dissolves alkaline and iodine, but the solutions by keeping undergo decomposition. It sparingly dissolves sulphur and phosphorus: the ethereal solution of phosphorus is luminous in the dark, when poured on hot water. Dissolves the volatile oils, most of the fatty and resinous substances, as of the vegetable alkalies, urea, and osmazome.

CHARACTERISTICS.—Sulphuric ether may be recognized by its combustibility, its yellowish white flame, its volatility, its peculiar odour and change of character, its complete solubility in alcohol, and its sparing solubility in water, consequence of which, when mixed with water and agitated in phials, mixture speedily separates, on standing, into two layers.

COMPOSITION.—The following is the elementary composition of ether:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Dumas &amp; Bouillay.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>24</td>
<td>64·87</td>
<td>65·03</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>13·51</td>
<td>13·85</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>21·62</td>
<td>21·24</td>
<td></td>
</tr>
</tbody>
</table>

\[\text{Ether} \quad 1 \quad 37 \quad 100·00 \quad 100·04\]

Chemists are not agreed as to the manner in which these elements are combined. Ether has been considered, at different times, as a dihydrate, a hydrate of etherine, or as the protoxide of ethereum.
In this diagram olefiant gas is regarded as a $\frac{3}{4}$ carbo-hydrogen, etherine as a $\frac{2}{3}$ carbo-hydrogen, and ethereum as $\frac{1}{2}$ carbo-hydrogen.

PURITY.—Absolutely pure ether is not necessary for medicinal purposes. Hence in the London Pharmacopeia we are told that ether which has a sp. gr. of 0.750 may be employed: but it would have been better to have limited the sp. gr. to 0.740. Of course the presence of alcohol or water increases the sp. gr. of this liquid; hence the lightest ether is to be preferred, as being the freest from these. Ether which contains no alcohol does not coagulate the serum of the blood. Pure ether does not redress litmus, but the ether of the shops usually does so slightly. Ten fluid ounces of water should not dissolve more than one fluidounce of ether and the solution should be quite transparent.

Physiological Effects. (a.) On Vegetables.—Ether, like alcohol acts as a powerful and rapid poison to plants.

(b.) On Animals. The effects of it on dogs have been determined by Orfila (Toxicolog. Générale), who found that half an ounce introduced into the stomach, and the oesophagus tied, caused attempts to vomit, diminished muscular power, insensibility, and death in three hours. Three drachms and a half injected into the cellular tissue of the thigh caused death on the fourth day. Jäger (quoted by Wibmer, in Die Wirkung, &c.) found that half an ounce of ether acted as a fatal poison to a crane: at the end of 48 hours its odour could be readily detected in its body. He made similar experiments with pigeons and ducks. One of the last mentioned animals took altogether an ounce of ether, yet was not dead at the end of 24 hours.

(c.) On man. The operation of ether is analogous to that of alcohol, but is much more rapid and transient. Swallowed in moderate doses it makes a powerful impression on the mouth, throat, and stomach, allays spasm, and relieves flatulence: but, according to some observers, it augments neither the heat of the body nor the frequency of the pulse (Schwilgué, Traité de Mat. Méd. 1818): also, Trouseau and Pidoux (Traité de Thérap. 1836). Its first effects on the cerebral functions those of an excitant, but the subsequent ones are those of a depressant agent. In somewhat larger doses it produces intoxication like that caused by alcohol. In excessive doses it occasions nausea, a copious flow of saliva, giddiness, and stupor.

The long and habitual use of ether diminishes the effect of this substance over the system, and therefore the dose must be proportionately increased. Dr. Christison mentions the case of an old gentleman who consumed sixteen ounces every eight or ten days, and had been in the habit of doing so for many years. Yet with the exception of an asthmatic cough for which he took the ether, he enjoyed tolerable health. The chemist Bucquet, who died of scirrhus of the colon, with inflammation of the intestines generally, took, before his death, a pint of ether daily to alleviate his excruciating pains (Merat and De Lens, D Mat. Méd.).

When the vapour of ether, sufficiently diluted with atmospheric air inhaled, it causes irritation about the epiglottis, a sensation of fulness in the head, and a succession of effects analogous to those caused by protoxide of nitrogen (vide p. 156), and persons peculiarly susceptible the action of the one are also powerfully affected by the other (Journ. Science, vol. iv. p. 158). If the air be too strongly impregnated with el
SULPHURIC ETHER.

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potation ensues. In one case this state continued with occasional
iods of intermission for more than 30 hours: for many days the pulse
so much lowered that considerable fears were entertained for the
life of the patient (op. cit.) In another case, an apoplectic condition,
ich continued for some hours, was produced.

modus operandi.—When ether is swallowed it is rapidly absorbed,
subsequently thrown out of the system by the pulmonary surface.
gendy (Elem. Compend. Physiol. by Milligan) says, that ether intro-
duced into the cavity of the peritoneum is discoverable in the expired
air by its odour. Thrown into the cavity of the pleura, it produces
dy death, and its odour is very obvious when we approach the mouth
the animal.—(Lectures on the Tissues, Lancet, Nov. 22, 1834).

1. Medicinal. (a.) Internal.—Ether is principally valuable as
peedy and powerful agent in spasmodic and painful afflictions, not
sequent on local vascular excitement, and which are accompanied by a
cold skin, and a small, feeble pulse. If administered during a
orxivm of spasmodic asthma, it generally gives relief, but has no ten-
cy to prevent the recurrence of the attacks. In cramp of the stomach,
iitus, and flatulent colic, its happy effects are well established. It is
etimes highly advantageous in a paroxysm of angina pectoris. Dur-
the passage of urinary or biliary calculi it may be used as a substitute
or in combination with, opium, to overcome the spasm of the ducts or
les through which the calculus is passing.

in the latter stages of continued fever, ether is sometimes admissible.
employed to relieve the subsultus tendinum and hiccup. Desbois
Rochefort (Mat. Méd.) administered it in intermittent fevers. He gave
bout half an hour before the expected paroxysm, it acted as a mild
oretic, and prevented the recurrence of the attack.

headache of the kind popularly called nervous, that is, unconnected
vascular excitement, is sometimes speedily relieved by ether. I
found it beneficial principally in females of delicate habits. In such
occasionally gives immediate relief, even when the throbbing of the
toral vessels and suffusion of the eyes (symptoms which usually contrac-
te the employment of ether), would seem to shew the existence
xitement of the cerebral vessels.

flatulence of stomach it may be taken in combination with some
atic water. Against sea-sickness it should be swallowed in a glass
white wine. Durande (Observ. sur l'Efficacité du Mélange d'Ether
iqu. et d'Huile volatile de Tereb. dans Coliques hépatiques produites par
pièces Biliaires, 1790), recommends a mixture of three parts ether
two oil of turpentine as a solvent for biliary calculi Bourdier (Mém.
Société de Méd.) employed ether to expel tape-worm. He adminis-
ted it by the stomach and rectum in an infusion of male fern, giving a
laf of castor-oil an hour after. In faintness and lowness of spirits it is
lar remedy. In poisoning by hemlock and mushrooms it has been
loyed (J. Frank, Toxicologie, s. 70,108). In asphyxia it has been
with benefit.

the vapour of ether is inhaled in spasmodic asthma, chronic catarrh,
yspnea, hooping cough, and to relieve the effects caused by the
dental inhalation of chlorine gas. It may be used by dropping some
in hot water, and inspiring the vapour mixed with steam, or it may
ropped on sugar which is to be held in the mouth. The inhalation of
the vapour of the ethereal tincture of hemlock is occasionally useful relieving spasmodic affections of the respiratory organs, and has been recommended in phthisical cases.

(b.) External.—The principal external use of ether is to produce a by its speedy evaporation. Thus in strangulated hernia it may be dropped on the tumour and allowed to evaporate freely: by this means a considerable degree of cold is produced, and, in consequence, the bulk of the pain diminished, whereby the reduction of the hernia is facilitated. Drop on the forehead, or applied by means of a piece of thin muslin, ether diminishes vascular excitement, by the cold produced from its evaporation, and is exceedingly efficacious in headache and inflammatory conditions of the brain. In burns and scalds it may also be employed as a refrigerant. If its evaporation be stopped or checked, as by covering with a compress, it acts as a local irritant, causing rubefaction, and, long-continued application, vesication. It is used with friction as a local stimulant.

2. PHARMACEUTICAL.—Ether is employed in the preparation of compound spirit of sulphuric ether. It is also used to extract the active principles of certain drugs, as of lobelia, aloes, musk, &c. The solution of which are contained in the London Pharmacopoeia is called ethereal tinctures (tinctura aetherica), or by the French pharmacologists ethéroïles. Ether is of assistance in determining the purity of some medicinal substances, as of aconitina and veratrum, which are very soluble in ether. It is also employed in toxicological researches, to remove bichloride of mercury from organic mixtures.

Administration.—It may be given in doses of from half a fluidrachm to two drachms:—a tea-spoonful is the ordinary quantity. This may be repeated at short intervals. It is usually exhibited in some aromatic water, and frequently in combination with other antispasmodic and stimulants, as ammonia, valerian, &c. It may be perfectly incorporated with water, or any aqueous mixture, by rubbing it with spermatic employed in the proportion of two grains for each fluidrachm of ethereal oil. (United States Dispensatory.)

Antidotes.—In cases of poisoning by ether the same treatment is be adopted as before recommended in cases of poisoning by alcohol.

Oleum Aethereum (Ph. L.)—Etthereal Oil.

History and Synonymes.—This liquid is commonly termed heavy of wine, or simply oil of wine. Dumas (Traité de Chimie, t. 5me, p. 54) says it was known to Paracelsus, who designated it sweet oil of vitriol. Modern writers have given it various appellations founded on its supposed composition. Thus according to Mr. Hennell it is a sulphate of hydrocarbon.—Dumas calls it sulphatic ether,—others a double sulph of ether and hydrocarbon,—while Liebig terms it ether-oil, sulphaether-oil, the term ether-oil being applied by this writer to a fluid containing carbonic hydrogen.

Preparation.—The following directions for procuring it are given the London Pharmacopoeia. "Take of rectified spirit two pounds, sulphuric acid four pounds, solution of potash, distilled water, of each a fluid ounce, or as much as may be sufficient. Mix the acid cautiously with the spirit. Let the liquor distil until a black froth arises; then im
necessarily remove the retort from the fire. Separate the lighter supernatant quar from the heavier one, and expose the former to the air for a day. Add to it the solution of potash first mixed with water, and shake them together. Lastly, when sufficiently washed, separate the ethereal oil rich subsides. I am informed by Mr. Hennell that 33 lbs. (avoird.) rectified spirit, and 64 lbs. (avoird.) of oil of vitriol, yielded, in one operation, 17 ounces (avoird.) of ethereal oil.

**THEORY OF THE PROCESS.**—In the first part of the process the changes are the same as those which occur in the process for making sulphuric ether. When the sulphuric acid and rectified spirit are mixed, sulphonic acid (ethero-sulphuric acid, according to Liebig) is formed, and by distillation water and ether are obtained.

The formation of ethereal oil depends, according to Mr. Hennell, on the decomposition of two equivalents or 216 parts of sulpho-vinic acid to one equivalent or 136 parts of ethereal oil, and two equivalents or 80 parts of sulphuric acid.

**INGREDIENTS USED.**

| Acid | Parts | Ph. L. | Ether Oil | 80
|------|-------|--------|-----------|-----
| Sulpohytic | 3 eq. Hydrogen | 8 | 1 eq. Ethereal Oil | 136
| Acid 216 | 2 eq. Sulphuric Acid | 80 | 2 eq. Sulphuric Acid | 80

This view of the subject is principally founded on the fact that sulphonic acid, or a sulpho-vinate, when heated, yields, among other products, ethereal oil.

But Liebig states that the compound formed by the mixture of sulphuric acid and rectified spirit is ethero-sulphuric acid, and that the heavy oil of wine (the ethereal oil, Ph. L.) is an ethero-sulphate of a ¾ carbodrogen, which he calls ether-oil (Aetherol). Consistently with this view we may account for the formation of the heavy oil of wine by supposing that by the heat employed, one equivalent or 117 parts of ethero-sulphuric acid are resolved into one equivalent or 28 parts of a fluid ¾ carbodrogen (ether-oil of Liebig), two equivalents or 80 parts of sulphuric acid, and one equivalent or 9 parts of water. By the union of the ¾ carbodrogen (ether-oil of Liebig) with one equivalent or 117 parts of ethero-sulphuric acid, there are formed an equivalent or 145 parts of ethereal oil of the Pharmacopoeia (the ethero-sulphate of Liebig’s et-er-oil).

**INGREDIENTS USED.**

| Acid | Parts | Ph. L. | Ether Oil | 145
|------|-------|--------|-----------|-----
| Ethero-sulphuric | 4 eq. Carbon | 24 | (Ether-oil Lieb.) | 28
| Ethero-sulphuric | 1 eq. Water | 9 | 1 eq. Water | 9
| Ethero-sulphuric | 2 eq. Sulphuric Acid | 80 | 1 eq. Sulphuric Acid | 80

During the process olefiant gas is evolved. By the mutual action of sulphuric acid and the ¾ carbo-hydrogen, water, sulphurous acid, and carbon, produced. The deposition of the last-mentioned substance is the cause the black froth alluded to in the Pharmacopoeia. The lighter superfluous liquor also referred to is the ethereal oil mixed with ether. The er evaporates by exposing the mixture to the air for a day. To remove traces of sulphurous acid, the oil is to be washed with a solution of etic potash. Liebig says alkalies decompose it (op. cit. p. 122).

**PROPERTIES.**—Ethereal oil is usually a yellowish oily liquid, having a peculiar aromatic odour, and a bitter aromatic taste. Its sp. gr. according to Mr. Hennell, is 1.05; but according to Scrullas, it is 1.13. It is
insoluble in water, but dissolves readily in alcohol and ether. It neither reddens litmus nor precipitates a solution of chloride of baryum, so the sulphuric acid contained in it seems to be completely neutralized.

According to Mr. Hennell ethereal oil dissolves a variable quantity a $\frac{3}{4}$ carbo-hydrogen, part of which separates in a crystalline form when the oil is kept for some time, or when exposed to cold. This crystalline compound, the existence of which was first pointed out by Mr. Hennell, is called wine-oil-camphor (Weinöl-Camphor) by Gmelin (Handb. d. Chemie, 2nd Ed. s. 405),—etherine by Liebig (Handwört d. Chemie, 1st Ed. s. 116).

When ethereal oil is slightly heated with water it yields ethereo-sulphuric acid (sulpho-vinic acid of Hennell) and a light oily fluid (light sweet oil of wine) which floats on water. This substance is a mixture of two isomeric compounds,—the one a solid (wine-oil-camphor or etherine) the other a liquid (ether-oil of Liebig). Each of these compounds is a $\frac{1}{4}$ carbo-hydrogen (Liebig and Poggendorf, Handwört. d. Chemie 1st Ed. Bdes. s. 119).

Characteristics.—Etheral oil is recognized by its oily appearance, its peculiar odour and taste, its slight solubility in, but greater specific gravity than, water, and its solubility in ether and alcohol. If it be heated in a test tube it yields an inflammable vapour which burns like olefiant gas, and a carbonaceous residue which contains sulphuric acid as is proved by lixiviating with water and testing by chloride of baryum. Ethereal oil added to a solution of chloride of baryum, occasions no clouder, but if we evaporate the mixture to dryness, the residue is found to contain sulphate of baryta.

Composition.—Three chemists have analysed ethereal oil, namely, Hennell, Serullas, and Liebig. The results of two only of these agreed, those of Liebig and Serullas.

<table>
<thead>
<tr>
<th>LIEBIG AND SERULLAS</th>
<th>HENNELL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eq.</strong></td>
<td><strong>Eq. Wt.</strong></td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>2</td>
</tr>
<tr>
<td>Carbon</td>
<td>8</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>8</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
</tr>
<tr>
<td>Ether &amp; Oil (Ph.L)</td>
<td>1</td>
</tr>
</tbody>
</table>

Mr. Hennell regards ethereal oil as a sulphate of hydrocarbon, where Dumas considers it to be a sulphate of ether. Serullas called it a donor sulphate of ether and hydrocarbon. Lastly, Liebig regards it as an ether sulphate of (a $\frac{1}{4}$ carbo-hydrogen, which he terms) ether-oil.

These different opinions may be thus represented:—

<table>
<thead>
<tr>
<th>LIEBIG</th>
<th>SERULLAS</th>
<th>DUMAS</th>
<th>HENNELL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Ether-oil, subp. Ad.</td>
<td>117</td>
<td>2 eq. Sulphuric Acid 21</td>
<td>4 eq. Sulphuric Acid 28</td>
</tr>
<tr>
<td>1 eq. Ether-oil</td>
<td>25</td>
<td>1 eq. Ether</td>
<td>57</td>
</tr>
<tr>
<td>Ether-oil</td>
<td>143</td>
<td>1 eq. Sulphate Ether</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 eq. Sulphate Hydrocarbon</td>
<td></td>
</tr>
</tbody>
</table>

Physiological Effects.—These have not been determined. In fifteen drops to a small rabbit: death took place within an hour. The symptoms were indisposition to move, apparent tendency to sleep, followed by incapability of supporting the erect position, occasional convulsive movements, grating of the teeth, and insensibility. The body was...
SPIRIT OF NITRIC ETHER.

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The heart was still beating, and its right naries were gorged with purple blood. Etheral oil, therefore, acts on the nervous system in a somewhat analogous way to ether.

Uses.—Etheral oil is used in the manufacture of the spiritus ætheris phœnecis compositus of the Pharmacopœia. This preparation is an imitation of the liquor anodymus mineralis of Hoffinan. It is made by mixing eight fluidounces of sulphuric ether, sixteen fluidounces of rectified spirit, and three fluidrachms of etheral oil. In addition to the stimulating and antispasmodic qualities derived from the ether and alcohol, it is supposed by some to possess anodyne properties highly useful in nervous irritation, and want of sleep arising from that cause.

"Dr. Hare," in his Chemical Compendium, "reports the opinion of Physick and Dewees in favour of the efficacy of the official oil of laudanum, dissolved in alcohol, in certain disturbed states of the system, as an anquillizing and anodyne remedy." (United States Dispensatory.) The compound spirit of sulphuric ether is sometimes employed as an adjunct to laudanum, to prevent the nausea which the latter excites in certain bits. Its dose is from half a fluidrachm to two fluidrachms, in any oper vehicle.

Spiritus ætheris Nitrici.—Spirit of Nitric Ether.

History and Synonyms.—Spirit of nitric ether was known to Raymond Lully in the 13th century. Basil Valentine, in the 15th century, taught an improved method of obtaining it (Geiger, Handb. d. Pharm.). It has been known by various names,—such as sweet spirit of nitre (spiritus tri dulcis),—spirit of nitrous ether (spiritus ætheris nitrosi), and nitre opis. Nitric ether was first mentioned by Kunkel in 1681.

Preparation.—The following directions for its preparation are given in the London Pharmacopœia:—"Take of rectified spirit three pounds, of nitric acid four ounces: add the acid gradually to the spirit, and mix: then let thirty-two fluid ounces distil." At Apothecaries' Hall it is prepared in an earthenware still (heated by the slow application of steam to the outer surface), with a condensing worm-pipe of the same material,—should be slowly distilled at a temperature of about 180° F. (Brandes Manual of Pharmacy).

Theory of the Process.—The changes in this process are complicated, consequence of the products being very numerous. The nitric acid is deprived of part of its oxygen, and thereby furnishes binoxide of nitrogen, and nitrous and hyponitrous acids, as well as some nitrogen and dioxide of nitrogen. The oxygen which is abstracted from the nitric acid unites with some hydrogen of the alcohol to form water, and with the carbon to produce carbonic acid.

One equivalent or 38 parts of hyponitrous acid react on two equivalents or 46 parts of alcohol, and produce one equivalent or 75 parts of nitrous ether (commonly termed nitric ether), and one equivalent or parts of water. The hyponitrous ether and some spirit distil over, and constitute the spirit of nitric ether of the Pharmacopœia.

Besides the above, which are the more essential changes, others take place by which additional products are obtained. Thus acetic, malic, salhydric?) and oxalic acids, are likewise produced, but in small quantities. The production of acetic acid may be accounted for by supposing either that a portion of the alcohol is deprived of part of its
hydrogen, or that some oxygen of the nitric acid unites with portion of hydrogen and carbon of the alcohol. The acetic acid re-acting some alcohol produces acetic ether, which distils over. The origin of malic (oxalhydric?) acid is probably similar to that of the acetic acid. The oxalic acid is produced by the union of a portion of the oxygen and the nitric acid with some carbon of the alcohol.

The following diagram will explain some of the more essential changes attending the production of hyponitrous ether.

\[
\begin{align*}
\text{2 eq. Alcohol} & \quad 46 \quad \begin{cases} 
2 \text{ eq. Oxygen} & 16 \\
2 \text{ eq. Hydrog.} & 2 \\
4 \text{ eq. Oxygen} & 32 \\
4 \text{ eq. Oxygen} & 32 \\
8 \text{ eq. Oxygen} & 64 \\
4 \text{ eq. Oxygen} & 48 \\
6 \text{ eq. Oxygen} & 48 \\
3 \text{ eq. Oxygen} & 24 \\
1 \text{ eq. Nitrog.} & 14 \\
3 \text{ eq. Nitrog.} & 42 \\
1 \text{ eq. Nitrog.} & 14 \\
4 \text{ eq. Carb.} & 24 \\
5 \text{ eq. Hydrog.} & 5 \\
1 \text{ eq. Hydrog.} & 1 \\
1 \text{ eq. Oxygen} & 8 \\
1 \text{ eq. Oxygen} & 8 \\
\end{cases} \\
\text{2 eq. Alcohol} & \quad 46 \quad \begin{cases} 
2 \text{ eq. Oxygen} & 16 \\
2 \text{ eq. Water} \\
4 \text{ eq. Water} \\
4 \text{ eq. Carbonic Acid} \\
1 \text{ eq. Nitrous Acid} \\
3 \text{ eq. Binox. Nitrog.} \\
1 \text{ eq. Hyponitr. Ether} \\
1 \text{ eq. Ether} & 37 \\
1 \text{ eq. Water} \\
\end{cases}
\end{align*}
\]

**Properties.**—Spirit of nitric ether, (Ph. L.), is a colourless limpid liquid, having a fragrant ethereal odour somewhat analogous to that of ripe apples, and a pungent, aromatic, sweetish, acidulous taste. Its sp. gr. should not exceed 0.834. It is very volatile, producing much cold by its evaporation. It is very inflammable, and burns with a whitish flame. By keeping, it becomes powerfully acid, and the strongly reddens litmus, and produces effervescence with the alkaline carbonates. It dissolves in alcohol and water in all proportions.

**Characteristics.**—It is principally distinguished by its peculiar odour, its inflammability, its lightness, and its miscibility with water. The spirit of nitric ether of the shops usually strikes a deep olive colour with the protosulphate of iron, thereby indicating the presence of the oxide of nitrogen, and produces, with tincture of guaiacum, a blue tinge which passes through various shades of green: this last effect probably depends on the presence of nitrous or nitric acid. These effects are invariably produced; as when spirit of nitric ether has been long kept, though it may still possess the proper odour.

**Purity.**—This compound is most extensively adulterated by mixing with rectified spirit and water. The fraud is recognized by an attentive examination of the flavour of the substance, and by taking the sp. gr. of the liquid. If the sp. gr. exceed 0.834, the presence of water may be suspected. Nitric or nitrous acid may be suspected, if the liquid possess the power of strongly reddening litmus, and of causing effervescence with the alkaline carbonates. Some years since, large quantities of spirit of wire, flavoured with nitric ether in order to evade the payment of the duty on spirit, were brought to England from Ireland, under the name spirit of nitric ether.

**Composition.**—The spirit of nitric ether of the Pharmacopia is a mixture of hyponitrous ether, alcohol, and water: the relative proportions have not been ascertained.
The ultimate composition of hyponitrous ether is the following:

<table>
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<tbody>
<tr>
<td>arbon</td>
<td>4</td>
<td>32·00</td>
<td>32·69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rogen</td>
<td>5</td>
<td>6·67</td>
<td>6·85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rogen</td>
<td>4</td>
<td>42·67</td>
<td>41·46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rogen</td>
<td>1</td>
<td>18·66</td>
<td>19·00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chemists are not agreed as to the precise manner in which these agents are associated. We may regard hyponitrous ether as the *drated hyponitrite of etherine, the hyponitrite of the oxide of etherum hale*, or the *hyponitrite of ether*. The following diagram illustrates these opinions:

| Etherine | 28 | 1 eq. Etherum | 29 | 1 eq. Ether | 37 |
| Water   | 9  | 1 eq. Oxygen  | 8  | 1 eq. Hyponitrous Acid | 38 |
| Hydro. Hyponitrite Ether | 75 | 1 eq. Hyponitrite Oxide Etherum | 75 | 1 eq. Hyponitrite Ether | 75 |

**Physiological Effects.**—Its effects on *vegetables* have not been ascertained.

I am not acquainted with any experiments made to determine its effects on *animals* generally. VETERINARIANS employ it as a diuretic on various occasions, and as a stimulant in the advanced stages of fever to use the exhausted powers of horses (Youatt, *The Horse, in the Library Useful Knowledge*).

On *man* its effects have not been satisfactorily ascertained. The inhalation of its vapour is dangerous when too long continued, as is proved by the following case. A druggist’s maid-servant was found one morning dead in her bed, and death had evidently arisen from the air of her apartment having been accidentally loaded with the vapour of this gas from the breaking of a three-gallon jar of it. She was found lying on her side, with her arms folded across the chest, the countenance and stare composed, and the whole appearance like a person in a deep sleep (Christison’s *Treatise on Poisons*).

Taken internally in moderate doses it acts as a diuretic. It is believed to possess diaphoretic properties. By some pharmacologists it is described as being refrigerant, a quality which it probably owes to the free and which it usually contains. I am unacquainted with the effects of moderate doses, but they are probably analogous to, though less energetic in, those of other ethereal compounds. Kraus (*Heilmittelrehe*) says, that twelve years of age took a draught in the morning fasting, and that caused violent colic which lasted for six hours, and was accompanied by vomiting. Probably these effects arose from the preparation containing a considerable quantity of free acid.

**Uses.**—It is employed as a diuretic in some disorders of children and mild dropsical complaints, as in the anasarca which follows scarlatina. It is given in conjunction with squills, acetate or nitrate of potash, or fox-wool. As a refrigerant and diaphoretic it is used in febrile complaints combination with the acetate of ammonia and tartar emetic. As a stimulant it is frequently useful in relieving flatulence and allaying
nausea. On account of its volatilily it may be applied to produce c by its evaporation.

ADMINISTRATION.—The usual dose of this liquid in febrile cases about half a drachm. When we wish it to act as a diuretic it should given in large doses, as two or three tea-spoonfuls.

ANTIDOTES.—In poisoning by the inhalation of the vapour of this compound, the treatment will be the same as that described for poisoning carbonic acid gas.

Acidum Aceticum.—Acetic Acid.

History.—Vinegar must have been known from the most remote periods of antiquity. It is mentioned by Moses (Numbers, ch. vi. v. 1490) years before Christ. Hippocrates (De natura muliebri) employs ἐλαιοκατάληπτον, or white vinegar, medicinally. Both Plutarch and Livy tell us that Hannibal, in his passage over the Alps, softened the rocks by it and vinegar. Geber (Investigation of Perfection, ch. iii.) was acquainted with the purification of vinegar by distillation. Stahl, in 1723, obtained concentrated acetic acid from the acetates by the action of sulphuric acid.

Natural History.—Free or combined with potash, lime, or ammoniacal acid is met with in the juices of many plants. Thus, Vauque found the acetates of potash and lime in the sap of the elm; and Moreau detected acetate of ammonia in the fruit of the Arcea Catechu. Acetic acid has been recognized in the gastric juice by Tiedemann and Gmelin. The acid found in the perspiration, urine, milk, and blood and which some have called acetic, is now generally believed to be a distinct substance, and is termed lactic acid. Gmelin (Handb. d. Chem.) says acetic acid has been found in some mineral waters. If the observation be correct, the acid is probably to be referred to some decomposed organic matter accidentally present in the water.

Preparation.—The acetic acid of commerce is obtained from two sources—vinegar and pyroligneous acid: the first is procured by exciting the acceous fermentation in certain liquors, the other by the distillation of wood.

1. By the Acetous Fermentation. (a.) Manufacture of Vinegar.—Vinegar may be procured by the fermentation of various substances; but that met with in English commerce, and which is employed in this country for domestic purposes, is prepared from malt, or a mixture of malt and raw barley, which is mashed with hot water, as in the ordinary operation of brewing. The cooled wort is then transferred to the fermenting tun, where it is mixed with yeast, and undergoes a vinous fermentation. The wash is then introduced into barrels, placed close together in a chamber, and a moderate heat (about 80° F.) is kept up until the acceous fermentation is complete. This process usually occupies several weeks, or even months. The liquor thus procured is not yet fit for sale. It is introduced into large tuns furnished with fit bottoms, on which is placed rape (the residuary fruit which has served for making domestic wines). These rape-tuns are worked by pairs; of them is quite filled with the vinegar from the barrels, and the other only three-quarters full, so that the fermentation is excited more easily the latter than the former, and every day a portion of the vinegar is conveyed from one to the other, till the whole is completely finished, and
ACETIC ACID. 219

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Theory of acetification.—The theory of the aceticous fermentation imperfectly understood. During the process oxygen of the air is sorbed, and carbonic acid is usually evolved, while the alcohol of the air gradually disappears, and acetic acid is produced. A remarkable distinction between the aceticous and vinous fermentation, is, that for the latter to be perfectly established, the presence of atmospheric air (or of oxygen) is essential, while for the former this is not necessary. It is usually supposed, that during the aceticous fermentation the alcohol is converted to acetic acid. Two equivalents or 46 parts of alcohol, with four equivalents or 32 parts of atmospheric oxygen, contain the elements of one equivalent or 51 parts of acetic acid, and of three equivalents or 27 parts of water.

INGREDIENTS USED.

\[ \begin{align*}
1. \text{ Atmospheric Oxygen} & \quad 32 \\
2. \text{ Alcohol} & \quad 46
\end{align*} \]

RESULTS.

\[ \begin{align*}
1. \text{ Oxygen} & \quad 3 \text{ eq.} & \quad 24 \\
2. \text{ Hydrogen} & \quad 3 \text{ eq.} & \quad 3 \\
3. \text{ Carbon} & \quad 4 \text{ eq.} & \quad 24 \\
4. \text{ Oxygen} & \quad 2 \text{ eq.} & \quad 16 \\
5. \text{ Water} & \quad 3 \text{ eq.} & \quad 27
\end{align*} \]

Several circumstances favour this hypothesis, such as the simultaneous appearance of alcohol and production of acetic acid—the strongest ones yielding the best vinegars: in other words, the quantity of acetic acid being proportional to that of alcohol; and, lastly, the formation of acetic acid by the slow combustion of alcohol, as well as by allowing a mixture of alcohol, water, and yeast, to trickle through beech shavings previously soaked in vinegar,—a mode of generating acetic acid practised in Germany. (Mitscherlich, Lehrbuch der Chemie.) But, on the other hand, is to be recollected, that many vegetable substances yield acetic acid during their spontaneous decomposition, without the production of alcohol. In alluding to these cases, Dr. Turner (Elem. of Chem.) observes—all these processes, however, appear essentially different from the properous fermentation above described, being unattended with visible wement in the liquid, with absorption of oxygen, or disengagement of carbonic acid.

The student will observe that the theory of acetification above given does not account for the appearance of carbonic acid during the process. The evolution of this substance is generally considered to be accidental, and not essential to the formation of acetic acid.

(c.) Properties of Vinegar.—Malt vinegar is of a yellowish or reddish brown, an agreeable acid taste, and a peculiar but pleasant odour. Its gravity varies from 1.0135 to 1.0251. (Thomson, System of Chemistry.) It is very liable to undergo decomposition when exposed to the air: it becomes turbid, loses its acidity, Acquires an unpleasant odour, and deserts a slippery gelatinous substance called the mother of vinegar,
when collected and dried, resembles gum, and is destitute of nitrogen. During these changes we observe mouldiness (Mucor mucedo) on its surface. Vinegar nourishes some microscopic animals, commonly thou very improperly termed eels (Vibrio Aceti). These may be destroyed by submitting the vinegar to heat. It is also infested by a small fly (Musca Cellaris).

(d.) Constituents of Vinegar.—Malt vinegar consists of water, acetic acid, colouring matter, a peculiar organic matter commonly termed mucilage, a small portion of alcohol, and a peculiar odorous principle. Vinegar makers are allowed to add one one-thousand part by weight of sulphuric acid. The strongest malt vinegar, called proof vinegar, (otherwise No. 24 vinegar) should contain 5 per cent. of real acetic acid; but according to Mr. Phillips, that of commerce does not usually contain more than 4·6 per cent. One fluidounce, or 446 grains of vinegar of the latter strength, should saturate very nearly 58 grains of crystallized carbonate of soda, or dissolve about 20 grains of pure white marble (carbonate of lime). In the Pharmacopoeia we are told that a fluidounce of vinegar is saturated by 60 grains of crystallized carbonate of soda, two grains being allowed for saturating the sulphuric acid permitted to be added by law, and for decomposing the sulphate contained in the water employed in vinegar-making (Phillips's Translation of the London Pharmacopoeia). The quantity of sulphate of baryta thrown down by the addition of solution of chloride of barium to a fluid ounce of vinegar, should not exceed 1·14 grains (Phillips). If the vinegar be free from copper, lead, and other metallic matter, it forms no precipitate on the addition of hydrosulphuric acid.

(e.) Distillation of Vinegar.—In the Pharmacopoeia this is ordered to be effected in a glass apparatus. The seven-eighths first distilled are to be kept for use; they constitute the acetum distillatum of the London Pharmacopoeia. If a copper still or pewter worm be employed, the distilled product has a metallic impregnation. On the large scale earthenware or silver condensing tubes are employed.

2. By the destructive Distillation of Wood.—This acid is procured by the distillation of wood in cast-iron cylinders. Oak, ash, birch, and beech woods, are employed: fir wood does not answer. The brushwood or spray of trees is sometimes used. The products are charcoal, which remains in the still, and various volatile substances; some condensible, others not.

The condensation of the vapours is effected by passing them through a worm, kept cool by immersion in water. The condensable products are water, acetic acid, and tar: these form crude pyroligneous acid. The incondensible products are carbonic acid and some inflammable gases: viz. carbonic oxide, light carburetted hydrogen, and olefiant gas. These are allowed to escape, or are burned in the furnace.
Distillation of Spray for Pyroligneous Acid.

The still, a cast-iron boiler.
The boiler door for the introduction of the spray.
Furnace door.
Still head.
Worm tub.

f. Waterspout for supplying the refrigeratory.
g. Gutter conveying the acid and tar from the worm to the barrels or other receiving vessels.

The receiver is usually a large cistern. In it the distilled liquor parates into layers: the lower one is tar; next to this, acetic acid and tar, holding in solution some tar; and, floating on the top, is a light. By means of a pump the middle stratum is removed, and is rectified by slow distillation. The first product that comes over is pyroxilic spirit; for this, acetic acid and water, with some essential oil of tar. This tinctured acid is of a brownish colour, and has an empyreumatic smell, it is saturated with lime, forming an impure acetate of lime, which is composed by a concentrated solution of sulphate of soda: sulphate of lime precipitates, and acetate of soda remains in solution. The latter is purified by crystallization, fusion in an iron pot, and re-crystallization.

From the crystallized acetate of soda, strong acetic acid is obtained by distillation with sulphuric acid. The proportions in the Pharmacopœia are—two pounds of the crystallized acetate, nine ounces of sulphuric acid, and nine fluidounces of water. On the small scale, the acid is distilled in glass or earthenware vessels. On the large scale, silver consisors are sometimes used. The above proportions are very nearly equal to one equivalent or 137 parts of crystallized acetate of soda, one equivalent or 49 parts of protohydrate of sulphuric acid, and six equivalents or 54 parts of water. The results of the distillation, on this calculation, will be the formation of one equivalent or 72 parts of anhydrous sulphate of soda, and the disengagement of one equivalent or parts of anhydrous acetic acid, which distils over with thirteen equivalents or 117 parts of water.

INGREDIENTS USED.

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>q. Water</td>
<td>54</td>
</tr>
<tr>
<td>q. Cryst. Ac.</td>
<td>117</td>
</tr>
<tr>
<td>q. Protohydr.</td>
<td>9</td>
</tr>
<tr>
<td>Sulph. Acid.</td>
<td>49</td>
</tr>
</tbody>
</table>

RESULTS.

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 eq. Water</td>
<td>34</td>
</tr>
<tr>
<td>1 eq. Acet. Ac.</td>
<td>31.51</td>
</tr>
<tr>
<td>1 eq. Soda</td>
<td>32</td>
</tr>
<tr>
<td>1 eq. Sulph. Ac.</td>
<td>40.40</td>
</tr>
<tr>
<td>1 eq. Anhyd. Acet.</td>
<td>51.51</td>
</tr>
<tr>
<td>1 eq. Sulph. Soda</td>
<td>72</td>
</tr>
</tbody>
</table>

ACETIC ACID.

Fig. 46.
Properties.—(a) Of Glacial Acetic Acid.—This is the protohydrate of acetic acid, which is crystallized solid at about 40° F. It is the strongest acid procurable, but, as it has no uses in medicine, will not require further notice.

(b) Of the Acetic Acid of the Pharmacopoeia.—This is a limpid, colourless liquid, having a pungent but agreeable odour, and an acetic taste. Its sp. gr. is 1.048. It possesses the usual properties of an acid, such as reddening litmus, causing effervescence with the alkaline earthy carbonates, and saturating bases. It is volatile, and by heat evolves an inflammable vapour.

(c) Of the Distilled Vinegar of the Pharmacopoeia.—This contains besides acetic acid and water, some alcohol and an organic substance derived from the mucilage of the vinegar. Hence when it is saturated with alkalies the solution becomes brown by heat, and deposits a dark coloured substance. Mr. Phillips states that a mixture of 15 parts by weight of the officinal acetic acid and 85 of water is equal in strength to distilled vinegar.

Characteristics.—Free acetic acid is known by its peculiar odour and by its volatility. Its vapour reddens litmus, and fumes with ammonia. This acid produces no precipitate with lime water, with solutions of barytic salts, or with a solution of nitrate of silver. It forms with potash a very deliquescent salt.

The neutral acetates are all soluble save those of molybdic and tungsten. The acetates of silver and protoxide of mercury are slightly soluble. The acetates are known by the acetic odour which they emit on the addition of sulphuric acid, and by the white lamellar and pearly precipitates which many of them produce with either the nitrate of silver or the protonitrate of mercury. All the acetates are decomposed by heat, and give results which vary somewhat according to the nature of the base. Some of the acetates, as those of potash, lead, and copper, evolve when heated an inflammable fluid called acetone or pyro-acetic spirit, whose composition is C₄H₆O₂.

Composition.—Anhydrous or real acetic acid consists of carbon, hydrogen, and oxygen, in the following proportions:—

<table>
<thead>
<tr>
<th>Element</th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Prout</th>
<th>Berzelius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>4</td>
<td>24</td>
<td>47.06</td>
<td>47.05</td>
<td>46.0</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>3</td>
<td>3</td>
<td>5.88</td>
<td>5.88</td>
<td>6.0</td>
</tr>
<tr>
<td>Oxygen</td>
<td>3</td>
<td>24</td>
<td>47.06</td>
<td>47.07</td>
<td>46.0</td>
</tr>
</tbody>
</table>

Anhydrous Acetic Acid

The acetic acid of the London Pharmacopoeia consists of water and pure acetic acid. As 100 grains of it saturate 87 grains of crystallize carbonate of soda, it must contain 30.8 per cent, of pure acetic acid (Phillips, op. cit.). This is very nearly one equivalent of acid to thirty equivalents of water.

<table>
<thead>
<tr>
<th>Element</th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Phillips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous Acetic Acid</td>
<td>1</td>
<td>51</td>
<td>30.35</td>
<td>30</td>
</tr>
<tr>
<td>Water</td>
<td>13</td>
<td>117</td>
<td>69.65</td>
<td>69</td>
</tr>
</tbody>
</table>

Purity.—The foreign matters likely to be present in acetic acid are excess of water, sulphuric, hydrochloric, or nitric acid, copper, lead, iron,
ACETIC ACID.

other metallic matter. Acrid substances, such as capsicums, grains of
adise, &c. are sometimes added to vinegar to increase its pungency.
ev are discovered by carefully saturating the vinegar with potash, and

tasting the solution with attention.

The strength of the acetic acid is ascertained by determining its
rating power. One hundred grains of the officinal acid should
urate 87 grains of crystallized carbonate of soda, or dissolve about 30
ms of white marble (carbonate of lime). One hundred grains of
filled vinegar should saturate 18 grains of crystallized carbonate of
a, or dissolve about 4 1/2 grains of white marble.

If sulphuric acid be present, a white precipitate is produced by the
lation of acetate of lead or chloride of barium. Hydrochloric acid is
ected by the white precipitate (chloride of silver) caused with nitrate
ilver. The presence of nitric acid is known by immersing a piece of
or in the suspected acetic acid: if nitric acid be present, nitrate of
er would be formed, which might be recognized by the subsequent
lation of hydrochloric acid.

Lead, copper, or tin, would be recognized by the precipitate produced
hydrasulphuric acid or ammonia. If lead be present, the iodide of
assium would throw down a yellow precipitate of iodide of lead.

Physiological Effects.—Before proceeding to notice the operation
actic acid on vegetables and animals, it may be useful to point out
of its effects on dead organic matters as have reference to the influ-
ce of this substance on living beings. In the first place, it is a well-
wn and powerful antiseptic, and is employed, partly on this account,
the ordinary operation of pickling, and in the preservation of animal
, and of anatomical preparations. The impure acetic acid obtained
the distillation of wood, acts more efficaciously in this respect than the
acid, on account of the creosote which it contains. Secondly, the
on of acetic acid on albumen, fibrin, and the sanguineous particles,
ers especial notice. Liquid albumen (as the serum of the blood,
the white of egg) is not coagulated by the ordinary acetic acid of the
ps. Coagulated albumen is readily dissolved by it with the evolution
itrogen, especially with the assistance of heat. Fibrin, as muscle or
crassamentum of the blood, also dissolve in it: the solution, by
oration, yields a gelatiniform mass. Caseum is coagulated by it.
changes the form of the red particles of frog's blood, and dissolves part
the red colouring matter (Müller's Physiology, p. 106). It is an
llent solvent of gelatine. Diluted and mixed with mucus, it acts as
gestive fluid (Müller, op. cit., p. 545).

a). On vegetables.—Distilled vinegar is ranked, by Achard, among
etable poisons (Decandolle, Phys. Végét.).

. p. 449) concentrated acetic acid acts as a caustic poison to dogs.
aces blackening of the mucous lining of the stomach, analogous to
produced by sulphuric acid. The same authority tells us that four
five ounces of common vinegar prove fatal to dogs in ten or fifteen
rs, if vomiting be prevented by the œsophagus. Injected into the
, vinegar does not appear to act very energetically. Viborg threw
ounces and a half of wine vinegar into the jugular vein of a horse:
next day the animal was well (Wibmer, Wirkung d. Arzneim.)
Analogous results have been obtained by Courten and Hertwich (quoted by Wibmer) and by Pommer (mentioned by Dr. Christison).

The impure acetic acid obtained by the distillation of wood, has been usually regarded as possessing much more activity than pure acetic acid of the same strength, in consequence of the presence of empyreumatic oil. An extensive series of experiments have been made with it on amphibials, birds, and mammals, by Berres, Kerner, and Schubart. From these it appears that pyroligneous acid is a cantharic poison; and that it destroys some of the lower animals, viz. amphibials, merely by contact with the external skin. Large doses affect the cerebro-spinal system, and cause giddiness, insensibility, paralysis, and convulsions.

A very constant effect was an affection of the windpipe and lungs. The acid was detected in the blood and secretions by its odour (Wibmer, *Wirkung d. Arzneim*).

(c.) On man.—In the concentrated state acetic acid is an irritant and corrosive poison. Its chemical influence depends principally on its power of dissolving fibrin, albumen, and gelatine, as before mentioned by which it acts as a solvent of many of the animal tissues. Applied to the skin it acts as a rubefacient and vesicant. Only one case of poisoning by its internal use is known. The patient (a girl) appeared to be intoxicated, complained of acute pain, and was violently convulsed (*Journ. Chim. Méd. t. vii*).

Swallowed in a very dilute form, and in moderate doses, acetic acid acts in a very analogous manner to the diluted mineral acids (see pp. 81, 84, and 96). Thus it is refrigerant, tonic, diaphoretic, and diuretic. Its local operation is astringent. Used moderately it assists the digestive process, and is therefore taken as a condiment. It is in repute with young ladies for diminishing obesity. It is said that the long-continued use of it, in full doses, will induce chronic diseases of the gastro-intestinal mucous membrane; and Morgagni says, it has even given rise to scirrhous of the pylorus.

Vinegar may be taken in considerable quantity at one time without inconvenience. Dr. Christison knew a case in which eight ounces were swallowed without injury.

The vapour of strong acetic acid is very pungent and irritating. The long-continued inhalation of acetic vapours, as by the workmen employed at vinegar-works, is said by Sundelin (*Handb. d. Heilmittelehre*) to be injurious to the lungs, and to bring on chronic inflammation of the organs.

Uses.—1. Medicinal.—Taken internally, common vinegar or acetic acid, properly diluted, is used for various purposes; the most important of which are, to allay febrile heat by its refrigerant qualities, to diminish inordinate vascular action, to relieve certain affections of the brain supposed to depend on, or be connected with, venous congestion, and to assist in its chemical properties of an acid. Thus, in fevers, whether simple or eruptive, but especially in those varieties commonly denominated putrid and bilious, vinegar (more or less diluted with water) is a most refreshing drink, allaying thirst, and diminishing excessive heat. In haemorrhages, as from the nose, lungs, stomach, or uterus, it is particularly beneficial by its refrigerant, sedative, and astringent qualities.

Vaporizes excessive vascular action, and promotes contraction of t...
Acetic Acid.

225

As a local astringent, it is injected into the nose in
stasis, and is used as a wash in profuse hemorrhoidal discharges.

Poisoning by opium, and some other narcotics, it is used to counteract

Effects of these substances: but as acetic acid forms soluble and

Powerful compounds with the active principles of some of these poisons,

Might not be exhibited until the contents of the stomach have been

Vacuated. In poisoning by the alkalies and their carbonates, and by

Acetic acid is recommended by Dr.

T. Thomson, to prevent the formation of carbonate of lead, which

Believes to be more apt to produce lead colic than the acetate. In

Sore, the acetic, as well as other vegetable acids, has been found serva-

ble. Clysters containing vinegar have been employed for the purpose

Provoking alvine evacuations in obstinate constipation and strangulated

This; of expelling the small round worm (Ascaris vermicularis); of

Peeking uterine and intestinal hemorrhage; and of relieving inflammation

Congestive conditions of the brain.

As a stimulant, disinfectant, and antiseptic, lotions containing acetic

Are used in gangrenous and other ill-conditioned ulcers. For these

Posses crude pyroligneous acid is more efficacious than ordinary

Vinegar, on account of the creasote and other substances which it con-

tains. In ulceration of the throat, in scarlatina and cynanche, gargles

Containing acetic acid or vinegar are sometimes used with good effect.

Dysuria, containing it, are useful as mild astringent applications in chronic

Uralnia, and for removing lime-dust adhering to any part of the globe

Dil of the eye.

Sponging the face, trunk, or extremities, with cold or tepid vinegar

Water, is frequently most refreshing and grateful in febrile disorders.

Diminishes preternatural heat, promotes the cutaneous functions, and

Stimulates as a beneficial stimulant to the nervous system.

Fomentations containing vinegar are used in bruises, sprains, &c.

The concentrated acetic acid sold in the shops under the name of

Rofigynous acid, is a valuable remedy for the cure of the different forms

Porrigo, popularly called ring-worm or scalled head. Its application,

Might be effected by means of a piece of lint wrapped round a

Wooden stick, causes acute but temporary pain, redness of the skin, and

Wearing of the abraded spots. One or two applications are usually

Efficent to effect a cure. Strong acetic acid is also employed as a

Ustic to destroy corns and warts. It has been proposed as a speedy

Means of exciting rubefaction and vesication, and for this purpose

Writing-paper or cambric, moistened with this acid, has been applied to

Neck in cases of croup.

Under the name of aromatic vinegar, concentrated acetic acid, flavoured
with other odorous substances, is employed in smelling-bottles and vinaigrettes. The vapour is inhaled to relieve fainting and headache; and is sometimes employed for correcting unpleasant odours, which it does not by destroying but by covering them.

2. **Pharmaceutical.**—Vinegar or acetic acid is employed for extracting the virtues of various medicinal substances, as squills, colchicums, and cantharides: the solutions are called *medicated vinegars* (acetica) or, by the French pharmacologists, *oxéolès*. A small quantity of spirit is usually added to them for the purpose of preventing the decomposition of the vinegar, and, in consequence of this, a small portion of acetic ether is generated. The preparations into the composition of which acetic acid and honey enter, are called *oxymels*, or the *acid mellites*. Acetic acid is employed also in the manufacture of the salts called *acetate*. Lastly, it is a powerful solvent of the gum-resins, and is used, on that account, in the preparation of the emplastrum ammoniaci.

**Administration.**—Vinegar is given internally in doses of from a tea-spoonful to half an ounce: used as a elyter, the quantity is one or two fluidounces. A refrigerant drink in fevers is made by adding one or two ounces of vinegar to a quart of water.

The *aromatic vinegar* (*acetum aromaticum*) of the shops is a solution of camphor and of the oils of cloves, lavender, and rosemary, in concentrated acetic acid. On the addition of water, part of the camphor precipitated. It is made in imitation of *Henry's aromatic vinegar*. The Edinburgh and Dublin Pharmacopoeias is an official substitute for the latter preparation: it is called *acidum aceticum camphoratum*. It is prepared by dissolving half an ounce of camphor (pulverized by means of a few drops of alcohol) in six fluidounces of acetic acid. These preparations are only used as errhines.

In the Edinburgh Pharmacopoeia is a very useless preparation called *acidum aceticum aromaticum*, made by digesting dried rosemary, dried sage leaves, dried lavender flowers, and cloves, in distilled vinegar. It is an imitation of the celebrated *Thieves* or *Marseilles vinegar* (*acetum quatuor furum*), once supposed to be a prophylactic against the plag and other contagious diseases.

As the medicinal value of *oxymel* (*oxymel simplex*) depends principally on the vinegar which it contains, it is best noticed here. In the London Pharmacopoeia this compound is directed to be prepared by mixing a pint and a half of acetic acid (Ph. L.) with two pounds of honey made into a jam.

This preparation has been reputed detergent, and, in consequence, has been employed in gargles. It is commonly esteemed expectorant and as such is used in slight colds. Diffused through barley water, forms a refrigerant and agreeable drink in febrile and inflammatory complaints. It is frequently used as a vehicle for other medicines. The dose of it is usually two or three spoonfuls.

**Antidotes.**—In cases of poisoning by strong acetic acid, the treatment should be that recommended for poisoning by hydrochloric and sulphuric acids.

*Creasotive.*—*Cre'asote*.

**History.**—This substance was discovered a few years since by Rhenbach, who termed it *creasote* (from κρέας, flesh; and σωζω, I preserve) or the *flesh-preserver*, on account of its antisepptic property. Its name is sometimes written *Creosote* or *Kreosote*. In the London Pharmacopoeia
is described as an oxyhydrocarburet (oxy-hydro-carburetum) prepared from pyroxilic oil.

NATURAL HISTORY.—It is an artificial product; and is obtained by the destructive distillation of organic substances. It is found in pyrolygous id, in tar, in Dippel's oil, in wood smoke, and empyreumatic waters.

PREPARATION.—The preparation of creasote is a very troublesome and tedious process. The following concise abstract of it is taken from Turv's Chemistry (5th ed. p. 872). Those portions of the oil (called in the Pharmacopoeia pyroxilic oil) distilled from wood-tar, which are more than water, are first freed from adhering acetic acid by carbonate of potash, and, after separation from the acetate, are distilled. A little phosporic acid is mixed with the product to neutralize ammonia, and other distillation resorted to. It is next mixed with a strong solution of potash, which combines with ereasote, allows any eupion which may present to collect on its surface, and by digestion decomposes other organic matter: the alkaline solution is then neutralized by sulphuric acid, and the oil which separates is collected and distilled. For the complete purification of the creasote, this treatment with potash, followed by neutralization and distillation, requires to be frequently repeated. For further details I must refer to Dumas' Traité de Chimie, and to the m. de Chim. et Physiq. t. 57, 1834.

PROPERTIES.—Pure creasote is colourless and transparent: it has a high active power, and an oleaginous consistence. Its odour is that of cooked meat, its taste burning and caustic, its sp. gr. 1.037 at 68° F. boils at 397° F.; and is fluid at —16°6° F. It is combustible, burning with a sooty flame. It absorbs chlorine, and is resinified by it. Nitric acid is decomposed by it, with the evolution of nitrous fumes. Sulphuric acid in small quantity reddens, and in large quantity blackens it. Potassium decomposes it, with the evolution of gas (hydrogen?) and the formation of potash, which combines with some inspissated creasote. It is soluble in alcohol, ether, sulphuret of carbon, eupion, naphtha, acetic acid, and terephyllic ether. It dissolves resins, various colouring matters (as of cochineal, saffron, and madder), and some salts (as the acetate of potash). It very little action on caoutchouc; and does not possess any acid or saline re-action on test paper. Mixed with water, it forms two compositions: one is a solution of 1:25 parts of creasote in 100 of water; the other, on the contrary, is a solution of 10 parts of water in 100 of creasote.

It coagulates the albumen of eggs and of the blood. Concentrated luminous liquids are immediately coagulated by it; dilute ones, slowly. Fibrin is not altered by it. It is powerfully antiseptic with respect to meat and fish. Tar, smoke, and crude pyrolygous acid, owe, if not the whole, of their antiseptic properties to it. According to J. R. Cormack (Treatise on Creosote, 1836), the only essential part of the mummifying process practised by the ancient Egyptians was the application of such a heat as would first dry up the body, and then decompose the tarry matters which had been previously introduced, and generate creasote.

CHARACTERISTICS.—The odour of ereasote is its most characteristic property. To this must be added its combustibility, its oleaginous varnish, its complete solubility in acetic acid and caustic potash, and action on albumen before mentioned.
PURITY.—Creasote, when pure, is perfectly colourless; but that which in commerce has frequently a more or less brownish tinge. Rectified oil of tar, capnomor, and almond oil, are substances which have been might be associated with it (Cormaek, op. cit.) These impurities are readily detected by mixing separate portions of the suspected liquid with acetic acid and caustic potash: pure creasote is completely soluble in these fluids; not so the adulterated.

COMPOSITION.—Ettling (Ann. de Chimie, liii. p. 333), analyzed creasote which was supposed to contain three per cent. of water. Making allowance for this impurity, its composition, as determined by this chemist, nearly as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>14</td>
<td>84</td>
<td>77.42</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>9</td>
<td>9</td>
<td>8.12</td>
</tr>
<tr>
<td>Oxygen</td>
<td>2</td>
<td>16</td>
<td>14.46</td>
</tr>
<tr>
<td>Creasote</td>
<td>1</td>
<td>109</td>
<td>100.00</td>
</tr>
</tbody>
</table>

At present, however, the equivalent of creasote must be considered uncertain, since no definite compound of this substance has been analyzed by which the combining proportion could be ascertained.

PHYSIOLOGICAL EFFECTS. (a.) On vegetables.—Plants moistened with creasote water fade and die. (Miguet, Recherches sur la Crésote, 183.) The injurious effects of smoke on vegetation are probably to be referred principally to the creasote which it contains.

(b.) On animals generally.—Insects (as flies), spiders, and small fishes, die in two minutes after their immersion in water containing a few drops of creasote suspended in it. According to Mr. Cormack, the effects of creasote on dogs are remarkably similar to those of hydrocyanic acid, and are much less apparent when this substance is injected into the carotid arteries than into the veins. When thrown into the latter suddenly stops the heart’s action and causes hurried respiration, one or two convulsive fits, shrill cries, and death. Injected into the carotid artery it produces coma. Introduced into the stomach it gives rise to dimness and fixation of the eyes, vertigo, and coma: when given in large quantities it also affects the heart. (Cormaek, op. cit. p. 66, et seq.) Corneliani (Jour. Chem. Méd. t. ii. ser. 10) and Miguet have observed inflammation of the gastro-intestinal mucous membrane of dogs poisoned by creasote, but which survived some time.

(c.) On man.—Creasote operates locally as an irritant and caustic. Applied to the skin it causes heat, redness, and the destruction of the cuticle, which comes away in the form of furfuraceous scales. On the tongue it produces a painful sensation. Dropped into the eye it occasions acute pain. Placed in contact with a suppuring surface whitens the part as does nitrate of silver. Swallowed in large doses causes vomiting and purging. The caustic effect of creasote doubtless depends on the same property which renders it capable of preserving meat and of coagulating albumen.

Unless largely diluted, it occasions, when swallowed, heat in tongue, pharynx, oesophagus, and stomach. Small doses, as one or two minims, produce in most individuals no other unpleasant effect than that just mentioned. Larger doses give rise to nausea, vomiting, verti
headache, and heat of head. Dr. Elliotson (Medico-Chirur. Trans. vol. xix.) knew a lady who increased the dose of creasote to forty drops before it disagreed: the addition of a single drop beyond this produced extreme giddiness, insensibility, and vomiting, followed by headache for several days. When given in moderate doses it does not affect the bowels; so that, as Dr. Elliotson has observed, "aperients are as requisite as if it was not taken." When, however, the dose has been considerably augmented, diarrhoea or even dysentery has been produced.

The influence of creasote on the urinary organs is sometimes very marked. Dr. Macleod (Med. Gaz. vol. xvi. 399, and vol. xvii. p. 653), was I believe the first who noticed that the urine acquired a blackish colour by the use of it. A similar effect is referred to by Dr. Elliotson. In some cases creasote is recognized, by odour, in the urine, showing that it has been absorbed. Occasionally increases the quantity of this secretion, but in diabetes it sometimes has an opposite effect. In some instances it has caused micturition and anguish, so that in its influence over the urinary organs it bears some resemblance to turpentine. Some other effects which have been ascribed it require further evidence to establish them.

Uses.—Various substances, some known to contain creasote, others opposed to do so, have long been used in medicine, in the same diseases which creasote itself is now employed: and, in consequence, it has been imagined that they owe part of whatever efficacy they really possess this substance. These remarks apply to tar, soot, crude pyrolignous acid, aqua Binelli, the empyreumatic water of Runge and Hanke, rothenider, and animal or Dippel’s oil. To this list should be added, according to Mr. Cormack (op. cit.), mummy.

As an internal remedy, creasote has been principally celebrated, in this country, as a remedy possessing extraordinary powers of arresting miting. It has, however, been greatly overrated. It is decidedly curative in inflammatory conditions and structural disease of the womb, and frequently fails in allaying the sickness dependent on organic diseases, as of the heart and kidneys. It is most successful in hysterical cases, and sometimes succeeds in pregnancy. Creasote was first employed to relieve vomiting by Dr. Elliotson (Medico-Chirurg. Tr. 1. xix.), to whose paper, as well as to that of Mr. Taylor, apothecary of the North London Hospital (Lancet, August 15, 1835), I must refer for useful illustrative of extraordinary success with it. It is regarded by Dr. Macleod (Med. Gaz. vol. xvi. p. 598, and vol. xvii. p. 653) as of unfruitful efficacy; and has completely failed in the hands of Dr. Paris appendix to the 5th edit. of the Pharmacologia, 1838.


† Pyrothondide (from πῦρ, fire; and δέμων, linen), or liquor pyrro-oleasus e linteo crasso, is a very popular remedy for tooth-ache and skin diseases. It is sometimes prepared by distilling rags, and is then called ray oil; but the common mode of preparing it is to burn a cone of paper on a plate or other cold body; it is then termed per oil. It has been analyzed by Herberger (Buchner, Repertorium, Bd. 32, 317). For further particulars concerning it, consult Merat and De Leus, Diet. Mat. med.; Dierbach, op. cit.; Schwartz, Pharm. Tabell. 2. Aus.; L. Richter, Ausführl. zithein. Supplcm. Bd.
It sometimes relieves gastrodynia or flatulence, but is admissible in those cases only in which local stimulants are usually found beneficial. Where both hydrocyanic and creasote have been separately tried without success, Dr. Elliotson advises their union.

Creasote has been tried in a few cases of diabetes. In some instances both the quantity and saccharine quality of the urine (Dr. Elliotson, Med.-Chir. Trans. and Professor Berndt, Lancet, July 18, 1835) has been diminished. In no case does it appear to have effected a permanent cure.

In neuralgia, hysteria, and pulmonary diseases, it has also been used with occasional advantage: but a more extended experience is required to establish its efficacy in these cases.

As an external agent creasote may frequently be employed with great advantage. It has been successfully applied to relieve toothache. After carefully cleaning out the cavity of the tooth, a drop of creasote may be introduced by means of a camel's hair pencil, and the cavity filled with cotton soaked in this liquid. As a local application to chronic skin diseases (particularly the different forms of porridge and impetigo) it is of considerable value. Where a caustic application is required, it may be applied undiluted; but for other purposes it is used either in the form of ointment, or dissolved in water as a wash. Creasote may be beneficially used as an application to foul and indolent ulcers. It serves the double purpose of stimulating the living surface (and thereby of changing the quality of actions going on in the part), and also of preventing the putrefaction of the secreted matters. It is sometimes applied pure, but more commonly diluted with water. In hemorrhages it acts as a more efficient styptic, partly in consequence of its power of coagulating albuminous liquids, and thereby of causing the formation of a clot, and partly by causing contraction of the bleeding vessels. Creasote water may be applied either to bleeding wounds and leech-bites, or introduced into the vagina in uterine hemorrhage, by means of pledgets of lint soaked in it. There are many other purposes for which creasote has been applied as a local agent, but which I think it sufficient merely to name, referring the reader to the various papers and works before quoted for further information. It has been employed to check caries, to restrain excessive suppuration, and to repress fungous granulations in burns and scalds; to act as a counter-irritant in chronic ophthalmia, in which disease it is sometimes dropped into the eye on the same principle that the nitrate of silver and other local stimulants are used; and to remove condylomatous and other excrescences. The inhalation of creasote vapour is occasionally useful in relieving excessive bronchial secretion. Dr. Elliotson cured two cases of chronic glanders in the human subject by injecting an aeous solution of creasote up the affected nostril.

Administration.—Creasote may be given, at the commencement of its use, in doses of one or two drops diffused through an ounce of water by the aid of mucilage: the dose should be gradually increased. As before mentioned, in one case forty drops were given with impunity: in another instance, ninety drops were administered in less than half a day, without any bad symptom (Mr. Taylor, Lancet, August 15, 1835).

As a caustic, undiluted creasote is sometimes applied by means of camel's hair pencil.

The unguentum creasoti of the London Pharmacopœia is composed of a fluiddrachm of creasote and an ounce of lard. It is used principally in
in diseases, as ringworm. The quantity of erasote in it may be increased or diminished according to circumstances. When used by way of friction, eight or ten drops of erasote to the above quantity of oil may be sufficient.

Lotions, gargles, or injections of erasote, are prepared by dissolving two to six drops (according to the circumstances of each case) in an ounce of water. A solution of this kind is sometimes mixed with baylisses.

The inhalation of erasote vapour may be effected by diffusing a few drops of erasote through water or a mucilaginous liquid, and breathing through this, by means of the ordinary inhaling bottle (see p. 51).

**Antidotes.**—In a case of poisoning by erasote, the depression of the vital powers is to be counteracted by ammonia and other stimulants. Mr. Cormeak suggests the use of chlorine, but the value of this agent has not been determined by actual experiment. Oleaginous and mucilaginous drinks are recommended by Corneliani, for the purpose of preventing the local action of erasote on the mucous lining of the stomach and intestines. Vinegar does not diminish, but, according to Cornelliani, increases its activity. Mr. Cormeak says albumen augments its poisonous operation. Bleeding is suggested by this writer, in order to relieve the distension of the heart, and thereby to excite the contractions of this viscus. Artificial respiration should on no account be omitted. Any inflammatory symptoms which may subsequently appear of course to be treated by the usual antiphlogistic measures.

**Petroleum.**—**Petroleum.**

**History.**—Herodotus (Melippome, excv.) mentions the petroleum rings of Zacynthus (now called Zante) more than 400 years before Christ. The substance known to mineralogists as petroleum is the black naphtha (μαύρος) of Dioscorides (lib. i.), the bitumen liquidum of Pliny (lib. xxxv.)

**Natural History.**—There are two varieties of liquid bitumen or meral oil: one is transparent and nearly colourless, or only slightly yellow, and when burnt leaves no residuum; the other is thick, of a reddish brown colour or blackish, and leaves, after combustion, a black oil. The first is called naphtha (a Chaldaean word); the second troleum (from petra, a rock; and oleum, oil) or rock oil, because it is constantly found exuding in the form of an oily liquid from rocks. Both kinds are supposed to be produced by the decomposition of organic vegetable matter, for they are always found in Neptunian rocks, and they appear sometimes to be one of the products of the decomposition of oil (Berzelius, Traité de Chim. t. 6me.) From the investigation of Mr. Christeron and Gregory (Tr. Roy. Soc. Edinb. vol. xiii. p. 1), it appears probable that some varieties of petroleum, as that of Rangoon, are products of destructive distillation, since they contain paraffine and eupion, substances obtained from organic bodies by heat.

Petroleum is found in this country at Ormskirk in Lancashire, at Oldbrook Dale in Derbyshire, and at St. Catherine's Well near Edinburgh. In France it is produced at the village of Gabian in Languedoc, and hence it was termed Oleum Gabianum. It is also found in various parts of Europe, especially in Italy. In the United States of
America it is met with in various places: that from the shore of Seneca Lake in New York is called \textit{Seneka oil.} Several of the West Ind Islands, especially Barbadoes and Trinidad, yield it. The Barbadoes petroleum (\textit{Petroleum Barbadense}, Ph. Lond. et Dubl.; \textit{Pisselœum Indicum Dale}) is commonly termed \textit{Barbadoes Tar}, or \textit{B. Naphtha.} That import by Mr. Clarke professes to be the produce of the springs on Mount Hoo estate, in Barbadoes. In various localities of Asia, petroleum is met with in great abundance.

\textbf{Properties.}—Barbadoes petroleum, at ordinary temperatures, has the consistence of treacle: its colour is reddish brown or blackish; its odor and taste are bituminous. It floats on water: is combustible, yielding thick black smoke, and leaving a carbonaceous residuum. It is insoluble in water.

\textbf{Composition.}—The ultimate constituents of Barbadoes petroleum are carbon and hydrogen, with small quantities of oxygen and nitrogen. In distillation, five parts by measure yield rather more than four parts of yellow oily fluid, somewhat similar in appearance to the liquid carbon hydrogen obtained in the manufacture of oil-gas. The residuum of the retort is a substance analogous to asphaltum. It yields destructive distillation traces of ammonia. Some kinds of petroleum contain paraffine and eupion.

\textbf{Physiological Effects.}—Petroleum possesses stimulating properties which are principally observed in its effects on the organs of secretion (the skin, the kidneys, and the mucous membranes), the activity of which it promotes: hence it has been called sudorific, diuretic, expectorant, &c. It is said to be an excitant to the lymphatic vessels and glands.

\textbf{Uses.}—As an internal remedy it is employed in chronic pulmonary affections (as winter coughs, old asthmas, &c.), in obstinate skin diseases (as lepra, psoriasis, and impetigo), and against tape-worm.

As an external agent it is applied to obstinate ulcers, as lupus, and cutaneous diseases, and is employed as a stimulating liniment in chronic rheumatism, paralysis, and chilblains.

\textbf{Administration.}—The dose of Barbadoes petroleum is a small teaspoo angel given in any convenient vehicle (as some aromatic water, tea, spirit). The quantity should be gradually increased. It is said that an ounce has been taken in the day without inconvenience.

\textit{Succinum.}—\textit{Amber.}

\textbf{History.}—Amber was known to Thales of Miletus, 600 years before Christ. He was the first who noticed that when rubbed it acquired the power of attracting light bodies. Hence arose the term electricity, from \textit{ηλεκτρον}, amber. Theophrastus (\textit{De lapidibus}) also mentions this property.

\textbf{Natural History.}—Amber is found in different parts of the world. The principal portion of that met with in commerce, comes from the southern coasts of the Baltic, in Prussia, and is cast on the shore between Königsberg and Memel. It is supposed to be disengaged, by the action of the sea, from beds of lignite.

The vegetable origin of amber is shown by various facts. It is usual associated with substances (bituminous wood, coal, &c.) known to be derived from plants. Externally we observe on it various impressions on the branches and bark of trees; and inclosed in it are insects at
ats of plants (as the wood, leaves, flowers, and fruit). According to D. Brewster (Edinb. Philosoph. Journ. vol. ii.) its optical properties those of an indurated vegetable juice. From these circumstances, as all as from its chemical composition, amber is supposed to have been ainous exudation from some tree. Now as the wood, leaves, blossoms, fruit of some coniferous plant are found in amber, this plant has en supposed to be the amber tree: and a microscopic examination of wood leads to the conclusion that the amber tree is a species, though probably an extinct one, of the genus Pinus, closely allied to P. balsamea.ope, On Succinic Insects, in Trans. Entom. Soc. vols. i. and ii.)

Properties.—It occurs in irregular shaped pieces, usually flat and new what rounded at the sides. Its colour is yellowish white (succi-
m album), yellow (s. citrinum), or reddish (s. rubrum). It is usually nslucent, sometimes opaque or transparent: it is tasteless and odour-
s. Its sp. gr. is about 1·07. It is brittle, yields readily to the knife, a conchoidal vitreous or resinous fracture, and becomes negatively tical by friction: it contains various insects which, apparently, at have become entangled in it while it was soft and viscid. (For an count of these, consult Mr. Hope’s paper before quoted; also Bur-

Heated in the air, amber fuses at about 541° F., then inflames, and burns with a yellow flame, emitting a peculiar odour, and leaving behind aht shiny black coal. It cannot be fused without undergoing some chemical change. It evolves water, volatile oil, and succinic acid: the individual mass is termed colophonium succini. By destructive distillation a retort or alembic, amber yields first an acid liquor (which contains cimic and acetic acids), then some succinic acid deposits in the neck the retort, and an empyreumatic oil (oleum succini) comes over, at first n and yellowish, afterwards brown and thick: towards the end of the operation, a yellow light sublimate is observed in the neck of the retort; s called, by Berzelius, crystallized pyrétique; by Vogel, volatile resin amber; by Gmelin, amber-camphor. An inflammable gas is evolved ring the whole time of the operation.

Composition.—The ultimate constituents of amber are carbon,rogen, and oxygen. The proximate principles are a volatile oil, two ins, succinic acid, and a bituminous substance.

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<td>80·59</td>
<td>70·68</td>
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<td>brien</td>
<td>7·31</td>
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<tr>
<td>alogen</td>
<td>6·73</td>
<td>7·77</td>
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<td>res (silica, lime, and alumina)</td>
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<th>Proximate Constituents.</th>
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<tr>
<td>(Berzelius)</td>
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<tr>
<td>Volatile Oil</td>
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<td>Two Resins</td>
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<td>Succinic Acid</td>
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<td>Bitumen</td>
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The volatile oil has a strong but agreeable odour. The resins are ible in both alcohol and ether: if an alcoholic solution of the two ins be prepared by heat, and then allowed to cool, one of the resins posits. Succinic acid is white and crystalline, soluble in water, trely so in cold, but more so in boiling, alcohol. It is distinguished m benzoic acid by its insolvency in oil of turpentine. Succinate of amonia throws down a reddish precipitate with the persalts of iron. e bituminous matter constitutes the principal part of amber: it is
insoluble in alcohol, ether, the oils both volatile and fixed, and alkaline solutions.

Characteristics and Purity.—The resins copal and ani

insoluble internally, contains succinatus, rectified drachm, lant solutions. The

like lant, the

try. Dispensatory). The oil obtained by the destructive distillation of amber, when rectified by three distillations, constitutes the oleum succini of the Pharmacopoeia.

Oleum Succini.—This oil, prepared as above mentioned, is a powerful irritant, and when rubbed on the skin acts as a rubefacient. Taken internally it operates, like most other empyreumatic oils, on the nervous system, and is used as a stimulant and antispasmodic. Its dose is from five to fifteen drops. In the former edition of the London Pharmacopoeia there was contained a formula for the preparation of the spiritus ammos succinatus, made in imitation of the celebrated eau de luce (the history of which has been fully detailed by Beckmann, in his History of Invention, vol. iv. p. 595). Its active ingredient is ammonia, but the oils of amber, lavender, and mastich, entered into its composition. It is a powerful stimulant, and was employed as an application to the nostrils in fainting fits, hysteria; and also internally, in doses of from ten to thirty drops.

Acidum Succinum.—This, though contained in the Dublin Pharmacopoeia, is, I believe, never used in medicine. It was supposed to be the oil, antispasmodic, and was exhibited in doses of from five to twenty grains.

O'leum Animal'le.—Animal Oil.

This perhaps is the most convenient place for noticing the empyreumatic oil obtained by the decomposition of animal substances by heat. It is obtained in considerable quantities in the manufacture of ivory black (see p. 178), and is sold under the name of animal or Dippel's oil, is identical in its nature with the oleum corru cervi, or oil of hartshead, formerly used in medicine. As usually met with, it is a thick, brown viscid oil, having a most repulsive odour. By distillation, however, it may be rendered colourless and limpid, but is soon altered by the action of air and light. Its ultimate constituents are carbon, hydrogen, nitrogen, and oxygen. From its alkaline reaction it doubles contains ammonia. Unverdorben alleges that it contains four oily salifiable bases, to which he has given the names of odorine, animine, olanine, and ammon. Reichenbach has obtained creasote from it, and ascribes to this principle
supposed virtues of animal oil. Whatever may be its active prin-
tle, animal oil is undoubtedly a very powerful agent. In large doses
acts as an energetic poison, operating in two ways, locally as an
ant, remotely as a narcotic (Christison, Treatise on Poisons). Swal-
ed in moderate doses, it stimulates the vascular and nervous systems,
is esteemed antispasmodic. It has been employed as a local agent in
ises, gangrene, porrigo, &c. Internally, it has been used to prevent
attack of epilepsy or ague, as a stimulant in low fevers, and as anti-
smodic in hysteria and other affections of the nervous system accom-
nied with convulsive movements. Bremer (Traité sur les Vers
estin.) used Chabert’s oil (prepared by mixing three parts oil of tur-
tine with one part Dippel’s oil, and distilling three parts) as an
helmintic in tape-worm. The dose of animal oil is a few drops,
tiously increased.

Ac’didum Hydrocyan’icum.—Hydrocyan’ic Ac’id.

History.—The substance called Prussian or Berlin blue (Cæruleum Bo-
sicum seu Berolinense) was accidentally discovered by Diesbach at the
commencement of the 18th century, and various conjectures were soon offered
arding its nature. In 1746, Dr. Brown Langrish published some expe-
ments made with laurel water in order to investigate its effects on ani-
als (Physical Experiments upon Brutes). In 1752, Macquer an-
ounced that Prussian blue was a compound of oxide of iron, and some
boring principle which he could not isolate; and in 1772, Guyton
venue concluded that this principle was of an acid nature. Scheele,
1782, removed some of the mystery connected with Prussian blue, by
ning hydrous prussic acid from it. In 1787 Berthollet ascertained
acid to be a compound of carbon, nitrogen, and hydrogen. In 1800,
1802, Bohn and Schrader discovered it in laurel-water. Borda,
agnatelli, and Rasori, first employed the acid in medicine, from 1801
806. In 1815, Gay-Lussac obtained the acid in its pure anhydrous
, and explained its composition. (The chemical history of hyd-
onic acid is fully detailed in Thomson’s System of Inorganic Chemistry,
ii. 7th edition.) The medical history of it is contained in Dr. Gran-
’s Hist. and Pract. Treatise on this acid, 2d ed. 1820.

Synonyms and Etymology.—It has been denominated prussic
dum borussicum), zootic (acidum zooticum), or hydrocyanic acid:
first name indicates the substance (Prussian blue) from which it was
amed, the second refers to its animal origin, and the third indicates
stituents, hydrogen and cyanogen (so called from κιαρο, blue; and
ω, to produce; because it is one of the constituents of Prussian

Natural History.—Hydrocyanic acid is a product peculiar to the
ized kingdom. It may be readily procured from many vegetables,
 especially those belonging to the sub-orders Amygdalæ and
ose: as from bitter almonds, apple-pips, the kernels of peaches,
icots, cherries, plums, and damsons; the flowers of the peach, cherry-
el, and bird-cherry; the bark of the latter, and the root of the
untain ash. It is said to have been also obtained from plants of other
ies, as from Rhamnus Frangula and ergot of rye. In some of the
ables now referred to, hydrocyanic acid does not exist readily formed,
is a product of the process by which it is obtained. This has been
fully proved in the case of the bitter almond, and is inferred in other instances.

This acid is rarely, if ever, found in animals. One of its constituents (cyanogen) has, however, been detected, in combination with iron (forming Prussian blue) in the urine, the menstrual fluid, and the sweat, and with sulphur and potassium in the saliva. During the decomposition of animal matters, cyanogen is frequently generated: as when blood and carbonate of potash are calcined in an iron pot. It has also been stated that when cheese is exposed to the action of water and the sun, it disengages ammonia, and if treated, in this state, by alcohol, yields traces of hydrocyanic acid.

Preparation.—The processes for procuring this acid are very numerous. I shall only notice the most important of those which yield dilute acid employed for medicinal purposes.

(a.) By the action of dilute sulphuric acid on ferrocyanide of potassium.—The proportions directed in the London Pharmacopoeia for the preparation of dilute hydrocyanic acid, are two ounces of the ferrocyanide, an ounce and a half of sulphuric acid, and a pint and a half of distilled water. “Mix the acid with four fluidounces of the water, and to these, when cooled and put into a glass retort, add the ferrocyanide of potassium, first dissolved in half a pint of water. Pour eight fluidounces of the water into a cooled receiver; then, having adapted the retort, six fluidounces of acid, distilled with a gentle heat in a sand-bath, pass into this water. Lastly, add six more fluidounces of distilled water, as much as may be sufficient, that 12:7 grains of nitrate of silver, dissolved in distilled water, may be accurately saturated by 100 grains of this acid.”

If the distillation be performed in a [tubulated] retort, as directed the Pharmacopoeia, an adopter should be employed. When small quantities are to be operated on, we may conveniently employ two Florence flasks (one as the receiver, the other as the distilling vessel), connected by a glass tube curved twice at right angles. The receiver should be kept very cool, ice or snow being used if it can be procured; and the heat employed in distilling should be very moderate. The distilled liquid frequently contains a little sulphuric acid, and by standing deposits a small portion of Prussian blue. A second distillation, cautiously conducted, will often separate the sulphuric acid: but I have seen Prussian blue form after the hydrocyanic acid has been distilled three times.

The theory of the process, founded on the experiments of Mr. Ever (Lond. and Edinb. Phil. Mag. Feb. 1835) is as follows:—Six equivalents of 294 parts of protohydrided sulphuric acid react on two equivalents of 426 parts of crystallized ferrocyanide of potassium (composed of four equivalents cyanide of potassium, two of cyanide of iron, and six of water, and produce three equivalents or 384 parts of the bisulphate of potash; three equivalents or 81 parts of hydrocyanic acid, one equivalent or 17 parts of a new salt (which I shall term the bitiferrocyanide of potassium) and nine equivalents or 81 parts of water. The bisulphate and the new salt remain in the retort, while the hydrocyanic acid and the water discover. In the Pharmacopoeia an additional quantity of water is employed to assist the condensation of the acid.
The salt here called biferrocyanide of potassium, is termed, by Mr. Everitt, yellow salt. I have prepared it with the greatest care, but by ways found it to be white. Gay-Lussac also says it is white (Ann. chim. et Phys. t. 46, p. 77). By exposure to the air it becomes blue.

(b) By the action of hydrochloric acid on cyanide of silver.—This process, proposed by Mr. Everitt, yields an acid of uniform strength, and may be followed when the acid is required for immediate use. The pharmacopeial directions for its performance are (or rather ought to be) as follows:—Add 48⅔ grains of cyanide of silver to a fluidounce of distilled water, mixed with 39½ grains of hydrochloric acid. “Shake all these well-stoppered phial, and, after a short interval, pour off the clear fluid into another vessel. Keep this for use, the access of light being avoided.” The proportions directed by Mr. Everitt are 40 grains of cyanide, 7 fluidrachms and 20 minims of water, and 40 minims of dilute hydrochloric acid (sp. gr. 1·129). This gentleman says, that practitioners could obtain an ounce of the acid, prepared by this process, for shilling, while the manufacturer could obtain 50 per cent. profit by it. The theory of the process is as follows:—By the mutual reaction of one equivalent or 134 parts of cyanide silver and one equivalent or 37 parts of hydrochloric acid, there are obtained one equivalent or 144 parts of chloride of silver, and one equivalent or 27 parts of hydrocyanic acid.

(c) By the action of hydrochloric acid on bicyanide of mercury.—At apothecaries’ Hall hydrocyanic acid was formerly prepared from one part of bicyanide of mercury, one part hydrochloric acid (sp. gr. 1·15), and six parts of water. The mixture was distilled until six parts had passed over. The acid thus obtained had a sp. gr. 0·995, and its standard strength was such, that two fluidrachms of it dissolved 14 grains of the red oxide of mercury, thereby indicating a strength of about 9 per cent. of real acid.

The most convenient method of procuring concentrated or anhydrous hydrocyanic acid, is by the action of strong liquid hydrochloric acid on cyanide of mercury. The vapour should be passed over carbonate of lime, to deprive it of hydrochloric acid; and over chloride of calcium, to remove the water. The receiver should be immersed in a freezing mixture, consisting of ice and chloride of sodium.

The theory of the process is as follows:—Two equivalents or 74 parts of hydrochloric acid react on one equivalent or 254 parts of the cyanide of mercury, and form one equivalent or 274 parts of the bichlo-
ride of mercury, which remains in the retort, and two equivalents or parts of hydrocyanic acid, which distil over.

**INGREDIENTS REACTING.**

\[
\begin{align*}
2 \text{ eq. Hydrochloric Acid} & \rightarrow 2 \text{ eq. Hydrogen} \\
1 \text{ eq. Bicyanide Mercury} & \rightarrow 1 \text{ eq. Mercury}
\end{align*}
\]

**RESULTS.**

\[
\begin{align*}
2 \text{ eq. Hydrogen} & \rightarrow 2 \text{ eq. Hydrocyanic Acid} \\
1 \text{ eq. Mercury} & \rightarrow 1 \text{ eq. Bichloride Mercury}
\end{align*}
\]

(d.) By the action of tartaric acid on cyanide of potassium.—The process was proposed by Dr. Clarke, and adopted by Mr. Laming. The formula of the latter is the following:—22 grains of the cyanide of potassium are to be dissolved in 6 fluidrachms of distilled water, and this solution are to be added 50 grains of crystallized tartaric acid dissolved in 3 fluidrachms of rectified spirit. One fluidrachm of the decanted clear liquor contains one grain of pure hydrocyanic acid.

The objections to this process (which, however, has several advantages) are the trouble and expense of procuring pure cyanide of potassium and the liability of the salt to undergo spontaneous decomposition.

The theory of the process is the following:—Two equivalents or 1 parts of crystallized tartaric acid, one equivalent or 9 parts of water, and one equivalent or 66 parts of cyanide of potassium, react on each other and produce one equivalent or 189 parts of the crystallized bitartrate of potash, which precipitates, and one equivalent or 27 parts of hydrocyanic acid, which remains in solution.

**INGREDIENTS REACTING.**

\[
\begin{align*}
1 \text{ eq. Water} & \rightarrow 1 \text{ eq. Hydrocyanic Acid} \\
1 \text{ eq. Oxygen} & \rightarrow 8 \\
1 \text{ eq. Cyanogen} & \rightarrow 26 \text{ eq. Potassium} \rightarrow 40 \text{ eq. Potassium Cyanate} \\
2 \text{ eq. Cyanide Potassium} & \rightarrow 132 \text{ eq. Dry Tartarate} \\
2 \text{ eq. Crys. Tartaric Acid} & \rightarrow 150 \text{ eq. Water} \\
1 \text{ eq. Water} & \rightarrow 1 \text{ eq. Water}
\end{align*}
\]

**RESULTS.**

**Properties.** (a.) Of anhydrous hydrocyanic acid.—Anhydrous hydrocyanic acid is a solid at 0° F. (some state at 5° F.), having then the appearance of crystallized nitrate of ammonia: it readily melts, forming a limpid, colourless liquid, with an intense and peculiar odour; its taste is at first cool, then hot; at 45° its sp. gr. is 0.7058, and at 64° 0.6969. In this state it is exceedingly volatile: a drop placed on paper freezes by its own evaporation. It unites with water and alcohol in every proportion. At 79° or 80° F. it boils, forming hydrocyanic acid vapour, which is combustible; and when mixed with oxygen, explodes. Two volumes of the vapour require two and a half volumes of oxygen gas for their complete combustion. The products are two volumes of carbonic acid gas, one volume of nitrogen, and one volume of aqueous vapour.

Anhydrous hydrocyanic acid undergoes speedy decomposition. D. Christison says he has kept it unchanged for a fortnight in ice-cold water.

(b.) Of dilute hydrocyanic acid.—Dilute or medicinal hydrocyanic acid is a colourless, transparent liquid, having the taste and smell of the strong acid, but in a lesser degree. Heated in a tube it gives off a combustible vapour.

**Composition.**—The ultimate constituents of pure hydrocyanic acid are carbon, nitrogen, and hydrogen.
HYDROCYANIC ACID.

Carbon vapour... 1 or 2...
Nitrogen gas...
Hydrogen gas...

<table>
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<tbody>
<tr>
<td>Nogen</td>
<td>1</td>
<td>12</td>
<td>44.4</td>
<td>44.45</td>
<td>Carbon vapour</td>
</tr>
<tr>
<td>Nogen</td>
<td>1</td>
<td>14</td>
<td>51.9</td>
<td>51.85</td>
<td>Nitrogen gas</td>
</tr>
<tr>
<td>Hydrogen gas</td>
<td>1</td>
<td>1</td>
<td>3.7</td>
<td>3.70</td>
<td>Hydrogen gas</td>
</tr>
<tr>
<td>Hydrocyanic vapour</td>
<td>2</td>
<td>100.0</td>
<td>100.00</td>
<td>Hydrocyanic vapour</td>
<td>2</td>
</tr>
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The following diagrams illustrate the composition as well as the ducts of the combustion of the gaseous acid when exploded with nitrogen gas:

- Strength of the Dilute Acid.

In the Pharmacopoeia, hydrocyanic acid is directed to be prepared of such a strength that 100 grams of it will exactly precipitate 12.7 grams of nitrate of silver dissolved in water: the precipitate, which is cyanide of silver, should weigh 10 grams. Since the dilute acid should consist of:

| 
| Real Hydrocyanic Acid | 2.0 |
| Water | 98.0 |
| Dilute Hydrocyanic Acid (Ph. L.) | 100.0 |

Purity—Dilute hydrocyanic acid should be perfectly colourless; composed acid is frequently, but not invariably, coloured. It could be vaporizable by heat: this character shows the absence of ad impurities. The presence of metallic matter is recognized by thiosulphuric acid, which has no effect on the pure acid. If the acid is reddened litmus, it must contain some other acid, most probably sulphuric or hydrochloric. The presence of any foreign acid is likely determined by the hydrargyro-iodo-cyanide of potassium. This salt easily formed by adding a concentrated solution of bicyanide of mercury to a solution of iodide of potassium: a precipitate of white or nly crystalline plates immediately takes place: these are the salt in question. If a small portion of this salt be placed in diluted hydrocyanic acid, no change is observed unless some foreign acid be present: in latter event the red bimioide of mercury immediately makes its bearance. For this test we are indebted to Dr. Geoghegan (Dublin Jurnal, Nov. 1835). Sulphuric acid may be detected by a solution of iodide of barium: hydrochloric acid by nitrate of silver, which forms
therewith white chloride of silver insoluble in boiling nitric acid, whereas the white cyanide of silver is soluble in nitric acid at a boiling temperature. I would observe, that the presence of either of these acids is no further objectionable, than that it creates a difficulty in the determination of the strength of the hydrocyanic acid: while, on the other hand, it confers the advantage of rendering the hydrocyanic acid much less liable to decompose. The acid prepared from ferrocyanide of potassium will keep for years (Dr. Christison has had some unchanged for two years and a half, though it was exposed to day-light), owing, it is supposed, to the presence of some sulphuric acid. Mr. Barry adds a little hydrochloric acid to all his medicinal hydrocyanic acid, in order to preserve it. As air and light hasten, though they are not essential to the decomposition of the acid, they should be carefully excluded.

Characteristics.—The following are the best tests for hydrocyanic acid.

1. The odour.—The peculiar odour of hydrocyanic acid is well known. It must not be confounded with the odour of the volatile oil of bitter almonds. Orfila says, that this is the most delicate characteristic of the acid, since it is very marked when the liquid tests give very slight indications only. But I have not found this to be invariably the case: it depends much on the nature of the mixture containing the acid.

2. Formation of Prussian blue (ferrosesquicyanide of iron).—Add sufficient caustic potash to the suspected acid to saturate it; then a solution of some proto- and per-salt of iron: the common sulphate of iron of the shops, or the tincture of the chloride, answers very well, since both of these preparations usually contain the two (prot- and per-) salts of iron. A precipitate is thus obtained, which is liable to considerable variation in its colour, depending on the quantity of potash and the quantity of the ferruginous salt employed: it may be yellowish brown, greenish, or bluish. Then add dilute sulphuric or hydrochloric acid, when Prussian blue (ferrosesquicyanide of iron) will immediately make its appearance, if hydrocyanic acid were present.

The formation of Prussian blue is thus accounted for. When potash is added to hydrocyanic acid, water and cyanide of potassium are generated. By the reaction of this salt on a proto-salt of iron the protocyanide of iron is produced, while with a per-salt of iron it forms sesquisesquiyanide of iron. The two ferruginous cyanides, by their union, constitute the ferrosesquicyanide or Prussian blue.

The following diagram explains the reaction of nine equivalents of cyanide of potassium on three equivalents of the protosulphate, and for equivalents of the sesquisulphate of iron.

INGREDIENTS REACTING

<table>
<thead>
<tr>
<th>9 eq. Cyanide</th>
<th>3 eq. Protosulphate Iron 229</th>
<th>4 eq. Sesquisulphate Iron 400</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 eq. Potash</td>
<td>3 eq. Cyanogen 88</td>
<td>6 eq. Cyanogen 156</td>
</tr>
<tr>
<td>3 eq. Protosulphate Iron 229</td>
<td>3 eq. Sulfur, Aq. 120</td>
<td>6 eq. Oxygen 24</td>
</tr>
<tr>
<td>3 eq. Oxygen</td>
<td>3 eq. Iron 61</td>
<td>4 eq. Oxygen 48</td>
</tr>
</tbody>
</table>

RESULTS

| 9 eq. Potash | 9 eq. Sulphate Potash 7 |

3. Nitrate of silver.—This is by far the most delicate test of the presence of hydrocyanic acid. It causes a white precipitate of cyanid of silver, which is soluble in boiling nitric acid. By this latter character cyanide is distinguished from chloride of silver. If carefully
ied cyanide of silver be heated, it evolves cyanogen gas, known by its unburnstibility and the colour (violet or bluish red) of its flame.

4. Sulphate of Copper.—This test is applied as follows:—Supersaturate the potash; then add sulphate of copper. A greenish blue precipitate obtained, which, by the cautious addition of a few drops of hydrochloric acid, becomes white, if hydrocyanic acid be present. The objections to the test are, that the results are not sufficiently striking, and that an inexperienced manipulator may fail in getting any evidence of hydrocyanic acid. When excess of potash is added to hydrocyanic acid, obtain water, cyanide of potassium, and free potash. On the addition of sulphate of copper, hydrated oxide of copper, sulphate of potash in solution, and white cyanide of copper, are formed. The hydrochloric acid is added to redissolve the oxide of copper.

5. Tincture of guaiacum and sulphate of copper.—If tincture of guaiacum be added to a very dilute aqueous solution of hydrocyanic acid, a whitish precipitate (resin of guaiacum) is thrown down. If now a few drops of a solution of sulphate of copper be added, a blue colour is produced, which, rendered more intense by the addition of rectified spirit. Pagstecher, Berne (Quarterly Journal of Science, vol. x. p. 182), first proposed the tincture of guaiacum and hydrocyanic acid as a test for copper. I find that tincture of guaiacum and sulphate of copper, applied as directed, form a very sensible test of the presence of hydrocyanic acid: but fortunately it is not characteristic, since other agents also develop the same colour with it. Thus spirit of nitric ether produces a blue colour in the tincture of guaiacum.

Detection of this Acid in Cases of Poisoning.—As hydrocyanic acid is a substance which readily undergoes decomposition, it is not likely to be met with in bodies which have been inerred for many days. Has, however, been recognized in one case, seven days after death, withstanding that the trunk had not been buried, but had been lying in a drain (Chevallier, Ann. d’Hygiène Publ. ix. 337). In recent cases the acid is readily distinguished by its odour, with which, in some cases, the whole body is impregnated. The tests for this acid, already mentioned, will sometimes detect the poison in the filtered contents of the maw; but the foreign matters present may in some instances prevent its characteristic action. The best mode of proceeding, in that case, to introduce them into a tubulated retort, to add some sulphuric acid, to neutralize any ammonia which might be generated by the process of sublimation, and to distil by means of a vapour or water bath; then by the tests already mentioned.

It has been suggested that hydrocyanic acid may be formed during the process of distillation by the decomposition of the animal matters. But, Dr. Christison has justly observed, the objection appears only to rest on conjecture, or presumption at farthest. It is to be recollected that rye cheese has, under certain circumstances, been found to contain acid, as already mentioned. It is not improbable that it may be found in many animal substances during their spontaneous decomposition. Inured rye has been found to contain it.

Physiological Effects.—[a.] On vegetables.—Hydrocyanic acid is poisonous to plants. The stamens of Berberis vulgaris and the leaves of mosa pudica lose their irritability when the stems bearing them are immersed in the dilute acid (Macaire, Biblio. Universelle, xxxi. 244).
Seeds lose the power of germination by immersion in this acid. In those parts of lactescent plants which are poisoned by it, the milky juice does not flow from the cells or vessels in which it is contained. By chemical means it has been shewn that the acid becomes absorbed (Decandolle Physiol. Végét. p. 1357). Ammonia has, in some cases, appeared to favour the recovery of plants which had been exposed to the vapour of the acid (Macaire, op. cit.).

(b.) On animals generally.—Hydrocyanic acid is an energetic poison to all classes of animals. Experiments have been made with it on the following:—Mammalia, Aves, Reptilia, Amphibia, Pisces, Gastropoda, Annelida, Crustacea, Insecta, and Infusoria (Coullon, quoted by Wibmer, *Wirkung d. Arzneim.* 3 Bd. p. 110). The general effects are very similar on all classes, and consist essentially of loss of sensation and voluntary motion, with convulsive movements. The cold-blooded animal are more slowly affected by it than the hot-blooded ones.

Dr. Christison states that twenty-five grains of the strong acid, applied to the mouth, killed a rabbit within ten seconds. I once caused the instantaneous death of a rabbit by applying its nose to a receiver filled with the vapour of the pure acid: the animal was killed without the least struggle. If a drop of the pure acid be placed on the throat of a dog, or applied to the eye, death takes place in a few seconds. Inhaling the vapour decidedly produces death more quickly than any other mode of applying the acid.

d.) On man.—a. In small or medicinal doses.—Small doses of hydrocyanic acid sometimes relieve certain morbid conditions (as of the stomach), without producing any remarkable alteration in the condition of the general system. If the dose be cautiously increased, and its operation carefully watched, the following effects are usually observed: bitter but peculiar taste; increased secretion of saliva; irritation in the throat; frequently nausea; disordered and laborious respiration (sometimes quick, at others slow and deep); pain in the head, giddiness, obscured vision, and sleepiness. The vascular system is in some cases not obviously affected, but in others much affected, though not uniformly being sometimes quickened, at others reduced in frequency. In some instances faintness is experienced. Drs. Macleod and Granville (*Lond. Med. and Physic. Journ.* vol. xlvi. pp. 359 and 363) have noticed salivation and ulceration of the mouth during its medicinal use.

β. In poisonous doses: convulsions and insensibility: if death occur, takes place slowly.—Immediately after swallowing the acid, a remarkable bitter taste is experienced; this is soon followed by a sensation of faintness and giddiness, with salivation, and succeeded by tetanic convulsion and insensibility; the respiration is difficult and spasmodic; the odor of hydrocyanic acid may be recognized in the breath; the pupils are usually dilated, though sometimes contracted; the pulse is small and imperceptible. When recovery takes place it is usually very rapid, and the whole period of suffering seldom exceeds half an hour. However exceptions, to this exist, in which the symptoms have been prolonged for several hours.

The following case, related by Dr. Geoghegan, (*Dublin Med. Jour.* Nov. 1835), is an interesting illustration of these effects:—A gentleman aged 21, having been for some time subject to an uneasiness in the stomach, not actually amounting to gastrodynia, after having tried ma...
remedies in vain, was induced to have recourse to hydrocyanic acid. He commenced with one minim of the Dublin Pharmacopoeia, sp. gr. 0.998; his dose he repeated twelve times the first day, without any perceptible effect. On the following day he took half a drachm, with the same result. The third day his dose was a drachm, which he repeated the fourth day. On the fifth day he took a drachm and a half, still no effect of any kind. On the sixth day he increased his dose to two drachms. In about two minutes after taking this latter quantity, he experienced a sensation of extreme bitterness in the mouth, and having walked a few paces, was affected with great confusion, headache, and loud ringing in his ears. He now with difficulty retraced his steps, and leaning forward in a table, became insensible and fell backwards. In this state he remained altogether between three and four minutes, during which time he was violently convulsed. Two drachms of the spiritus ammoniacus were diluted with a little water, and applied as quickly as possible to the mouth, but as the teeth were clenched it could not be swallowed. The solid sesqui-carbonate of ammonia was then applied assiduously to the nostrils; its beneficial effects were soon apparent, and he was shortly able to swallow a little fluid. Sensibility now speedily returned, and omitting supervened, from which he experienced great relief; and at the expiration of half an hour he was quite well, with the exception of pain and feeling of distension in the head, which continued for the remainder of the day. After he had become insensible, and while leaning on the table, his thighs became rigid, and were drawn up on the abdomen; and when he was about falling, he was caught, and placed on the ground. The upper extremities were then observed to be also rigid, and on drawing them from the side, they forcibly reverted to their former position; the arms were shut, the teeth clenched, and the muscles of the face violently convulsed. It is deserving of notice that the old complaint was completely removed by this extraordinary dose.

viii. In poisonous doses: death rapid with or without convulsions.—In these cases the death is so rapid that, in the human subject, the symptoms have scarcely been observed. They are probably similar to those noticed in animals,—viz. imperceptible pulse, breathing not obvious, there may be two or three deep, hurried inspirations, insensibility, and death. Convulsions may or may not be present. The presence or absence of convulsions, as connected with the time within which death occurs in these cases, is sometimes of great moment. Some years ago the life of a prisoner almost turned on this point. The following is an instance of the case, which is more fully developed in Dr. Christison’s treatise on Poisons, and in the Medical Gazette, vol. viii. pp. 577 and 577. An apothecary’s maid-servant at Leicester, was found one morning dead in bed. The body lay in a composed posture—the arms crossed over the trunk, and the bed-clothes pulled smoothly up to the chin. At the right side lay a phial, from which about five drachms of the medicinal hydrocyanic acid had been taken, and which was corked and wrapped in paper. It was suspected that she took the acid to occasion miscarriage, that the apprentice was accessory to its administration; in consequence of which he was put on his trial. Now, the important question in the consideration of the medical witnesses was, could the deceased, or having drunk the poison, have had time to cork the phial, wrap it, and adjust the bed-clothes before insensibility came on? It was sup-
posed that if the death were of that slow description to allow of these acts of volition, convulsions would have occurred, and the bed-cloths would have been found disordered. On the other hand, those cases in which no convulsions occur usually terminate too quickly to allow of the above acts. The medical witnesses in the above case were not agreed in opinion: the majority thought that it was impossible the deceased could have had the power of corking the bottle. The jury very properly found the prisoner not guilty.

There are two points of inquiry connected with the action of this acid which are interesting, more particularly in a medico-legal point of view—namely, the time at which the poison begins to operate, and the period in which it proves fatal. No absolute answer can be given to either of these questions, since the strength and quantity of the acid exhibited and peculiarities (not known or understood) affect the result. Very strong acid, in large doses, begins to operate immediately on touching the throat, and death is almost instantaneous. The dilute acid, on the other hand, sometimes does not produce any obvious effect for several minutes and death may not occur for nearly half an hour. Of seven epileptic patients killed in one of the Parisian hospitals by hydrocyanic acid, some did not die for forty-five minutes. But I have not found the same quantity of the same acid kill different individuals of the same species in the same period of time.

**Morbid Appearances.**—The post-mortem appearances in cases of poisoning by this acid are the following:—Glistening and staring expression of the eyes, but which, however, is not a constant phenomenon since it was not observed in the seven Parisian epileptics: nor is it peculiar to this poison, for the same is observed after death by carbonic acid and in other cases (Christison) the odour of the acid is oftentimes very obvious in the blood, brain, chest, or stomach: the venous system is usually gorged with blood, while the arteries are empty: the blood is, in many cases, fluid, dark, or bluish black, and viscid or oily: the vessels of the brain and spinal marrow are frequently gorged with blood; and the cerebral ventricles sometimes contain a serous or sanguineous liquor; the lungs are, in some instances, natural—in others, turgid with blood: the internal lining of the stomach is sometimes red.

It has been stated by Magendie, that after death by the strong acid the muscles are not sensible to the galvanic influence. But this condition is very rarely present; indeed I have never observed it in animal killed by this acid; but Dr. Christison states he has occasionally found it. I have examined a considerable number of animals (principally rabbits) destroyed by hydrocyanic acid, and have always found the muscles to be powerfully affected by the galvanic influence: nor have I once met with a single case in which the heart had ceased to beat when the chest has been laid open immediately after death.

**Modus Operandi.**—There are several interesting subjects of inquiry connected with the operation of hydrocyanic acid, which, as they are principally theoretical, I shall briefly notice under this head.

(a.) *Local action.*—Dr. Christison says that Robiquet’s fingers became affected with numbness, which lasted several days, in consequence of their exposure for some time to the vapour of this acid (*Treatise on Poisons*, 3d ed. p. 698). This effect would appear to depend on th
local action of the poison on the nerves,—a mode of operation which we are constrained likewise to admit in the case of some other narcotics. See p. 13: also Müller’s Physiology, by Baly, vol i. p. 630). Some of the local effects produced by hydrocyanic acid are those of an irritant: such are, the aërid impression made by the vapour on the nose and mouth—the ptyalism—the vomiting and purging—and the redness of the mucous membrane of the stomach.

(b) Absorption.—That hydrocyanic acid becomes absorbed, is proved by its having been detected by Krimmer (quoted by Dr. Christison, p. 15), in the blood of animals poisoned with it, and by the odour of it exhaled by various parts of the body.

(c) Are the remote effects of this acid caused by its absorption?—In many cases the operation of hydrocyanic acid on the system is so rapid, and death so speedily follows the application of the poison, that we cannot satisfactorily account for the effects by the slow process of absorption: and hence many persons have felt themselves constrained to admit the agency of the nerves. I have before (p. 27) alluded to this subject, and have quoted a passage from Müller’s Physiology, in which the operation by absorption is defended. Further information on this point will be found at p. 627, vol. i. of this celebrated work. The principal arguments which have been adduced in favour of the agency of absorption are the following: first, that the acid produces no remote effects when applied either to the nerves or brain: secondly, that applied to the tongue or stomach, it operates as an energetic poison, although the nerves of these parts were previously divided: thirdly, that if the acid be applied to a part where circulation is arrested, the operation of the poison is prevented: fourthly, the activity of the acid is in proportion to the absorbing powers of the part with which it is placed in contact. See p. 18).

(d) Organs affected.—The parts specifically affected by this acid are the brain and true spinal system. The pain in the head, the insensibility, and the coma, are evidence of the cerebral affection; while the convulsions depend on the disorder of the true spinal system. Harx (die Lehre von d. Giften, 1sr. Bd. 2sr. Abt. S. 154,) mentions the following experiment performed by Wedemeyer (Versuche über das Nervensystem, S. 241, Vers. 7), and which shews the independent action of this acid on the spinal marrow: the spinal cord of a dog was divided between the last dorsal and first lumbar vertebrae, so that the hind legs were completely paralyzed and insensible to mechanical irritants: hydrocyanic acid was then introduced into one of the hind legs;—in one minute symptoms of poisoning commenced, the hind as well as the fore legs were violently convulsed,—and in twelve minutes the animal was dead. The affection of the respiratory and circulatory systems produced by hydrocyanic acid is probably only secondary: that is, is the result of the influence of this agent over those parts of the nervous system from which the respiratory organs and heart derive their nervous power. The insensibility caused by hydrocyanic acid occurs too rapidly, in many cases, to be the result of asphyxia caused by paralysis of the muscles of respiration.

(e) Condition of the brain and spinal marrow.—The precise pathological condition of the brain and spinal cord of an animal under the influence of hydrocyanic acid, cannot be positively determined, and is,
therefore, a matter of conjecture. Whatever it may be, it is probably identical with that which occurs during an epileptic paroxysm, and with that produced by loss of blood: for the essential symptoms (insensibility and convulsions occurring suddenly) are the same in all three states; and ammonia has been found to relieve them (see p. 171). Dr. Hall (Lect. on the Nerv. Syst. p. 139), has shewn that the convulsion from haemorrhage is spinal. Dr. Holst, Professor of Materia Medica in the University of Christiana, Norway, told me of a case of epilepsy under his care, in which it was observed that the pulse in one arm was always imperceptible during the paroxysm. On a post-mortem examination it was discovered that an anomalous distribution of the arteries existed,—that this arm was supplied with blood which had circulated through the brain. Hence it would appear that during the epileptic paroxysm the cerebral circulation was impeded. Does this happen in poisoning by hydrocyanic acid?

(f.) Cause of death.—In most cases the immediate cause of death is obstruction of respiration. In some instances it is stoppage of the heart’s action. There are cases, however, in which the death is too immediate to be produced by obstructed respiration, while, on opening the chest, the heart is found still beating: this I have observed in experiments on rabbits with strong hydrocyanic acid.

(g.) Cumulative effects.—Hydrocyanic acid is not usually regarded as a cumulative poison; but a case mentioned by Dr. Baumgärtner (quoted by Dr. Christison), as well as some other circumstances, seem to favour the reverse opinion (see Dr. Christison’s Treatise).

Uses.—We are indebted to the Italians (Borda, Brugnatelli, and Rasori) for the introduction of hydrocyanic acid into the Materia Medica. It was first employed by them at the commencement of the present century; namely, from 1801 to 1806 (Granville, Treatise on Hydrocyanic Acid, 2d ed. 1820).

(a.) Internal.—By the founders of the theory of contrastimulus this acid was regarded as a powerful asthenic or contrastimulant, and, therefore, as peculiarly useful in all diseases dependent on, or connected with, excitation. Hence it was employed in inflammatory affections. But subsequent experience has fully shewn that in these cases it possesses little or no remedial power.

In this country the reputation of hydrocyanic acid, as a medicinal agent, is chiefly founded on its effects in alleviating certain anomalous stomach complaints. It appears, from Dr. Granville’s statements (op. cit.), that laurel-water (which contains this acid) was used in these affections by Hufeland, Haller, Thuesen, Swedian, and Sprengel, between the years 1780 and 1796. But the first person who actually recommends hydrocyanic acid for them is Sprengel (Pharmacologia), in 1814. In 1819, Dr. A. T. Thomson detailed a case, which led him to infer that this acid would be an important agent in the treatment of dyspeptic affections. But the profession are principally indebted to Dr. Elliotson (Numerous Cases Illustrative of the Efficacy of the Hydrocyanic Acid in Affections of the Stomach, 1820) for a full investigation of its powers in these complaints.

Every practitioner is familiar with a stomach complaint in which pain of a spasmodic character is the leading symptom, but which is not essentially accompanied by pyrexia, as in gastritis—by tendency to faint, as in
ardialgia—by indigestion, as in dyspepsia, nor by loss of appetite; though one or more of these conditions may attend it. By some nosologists (as Sauvages and Sagar) it has been regarded as a distinct disease, and has been termed gastrodynia. It is not frequently accompanied by vomiting and precordial tenderness, which, however, cannot be regarded as indicative of inflammation, for various reasons; one of which is the alleviation of it often obtained by the use of stimulants and antispasmodics. What may be the precise pathological condition of this malady I know not. Dr. Barlow (Cyclopaedia of Practical Medicine, art. Gastrodynia) thinks the primary disease to be irritation or excitement of the mucous membrane of the stomach, whereby a redundant, dense, membranous, and opaque mucus is secreted, which accumulates and oppresses the stomach. The pain he supposes to arise from a contractile effort of the stomach to detach and expel the offending matter: but the immediate and permanent relief sometimes obtained by the use of hydrocyanic acid, is, I conceive, almost fatal to this hypothesis. Some time since I prescribed the acid for a lady who had suffered for months with gastrodynia, and who was persuaded, from her sensations, she had some organic disease. The remedy acted in the most surprising manner: in a few hours, to the astonishment of herself and friends, she was apparently quite well, and has since had no return of her complaint. It can hardly be imagined, that irritation of stomach can be rapidly removed by a substance which is itself an irritant. For my own part, I conceive the affection to be, essentially, a disordered condition of the nerves supplying the stomach, or of the nervous centres from whence those nerves are derived: and that it is frequently, but not invariably, accompanied with the irritation of stomach alluded to by Dr. Barlow. But be the proximate cause of the disease what it may, the beneficial effects of the hydrocyanic acid, in some instances of gastrodynia, are most astonishing, while in others it totally fails. In all the cases in which I have tried it, I have obtained either perfect success or complete failure: I have met with no cases of partial relief. It not only allays pain, but relieves vomiting; and in the latter cases, frequently when all other remedies fail. Dr. Elliotson mentions the following as the stomach affections relieved by it:—1st. those in which pain at the stomach was the leading symptom: 2dly, those in which the gastrodynia was accompanied by a discharge of fluid, constituting what is called pyrosis, or the water-brash: 3dly, when the excessive irritability of the stomach produces vomiting; and, 4thly, those disorders of the stomach, which, in some of their symptoms, resemble affections of the heart. Dr. Prout has found it useful in gastrodynia connected with colica pictorum.

I have also found it useful in a painful affection of the bowels analagous to that of the stomach, and which, therefore, might with propriety be termed enterodynia. The most remarkable case of this ind which I have met with, was that of a gentleman, a relative of one of my pupils. He had suffered for several months excruciating pain in the bowels, commencing daily about two o’clock, and only ceasing at night. It was, apparently, a consequence of an ague. He had been under the care of several country practitioners, and had tried a number of remedies (including opium and sulphate of quinia) without the least benefit. I advised the employment of the hydrocyanic acid, and accordingly five minimis were administered at the commencement of a
paroxysm: the remedy acted like a charm: all the unpleasant symptom immediately disappeared. Several doses of the acid were given before the time of the succeeding paroxysm, but the disease never returned and after employing the acid for a few days longer, he went back to the country completely cured.

I have seen hydrocyanic acid used with great success to allay vomiting and purging in severe forms of the ordinary English cholera, where opium has completely failed. In Asiatic or malignant cholera it has occasionally appeared to be serviceable.

As a remedy for affections of the pulmonary organs, hydrocyanic acid was at one time in great repute. It was said to be capable of curing slight inflammation of the lungs without the necessity of blood-letting of suspending or curing incipient phthisis, while in confirmed cases it smoothed the approach of death; of curing hooping-cough, and of removing all the symptoms of spasmodic asthma (see Dr. Granville's Treatise before referred to, and also Magendie's Recherches sur l'emploi de l'Acide Prussique, 1819). Experience has shown the fallacy of most of these statements. I have employed hydrocyanic acid in a considerable number of cases of phthisis, and have occasionally fancied that it relieved the cough and night-sweats; but these effects were only temporary. Cases of genuine spasmodic asthma are rare; but in two instances in which I have seen the acid employed, no relief was obtained. In allaying cough (especially the kind called spasmodic) I have, on several occasions, found it useful; but it has so frequently disappointed my expectations, that I now rarely employ it in any pulmonary diseases. I have never observed any ill effects from its use in these cases, though others assert they have.

It has been employed in affections of the nervous system. Cases of hysteria, epilepsy, chorea, and tetanus, have been published, in which this remedy has been found beneficial. I have seen it employed in the three first of these affections, but without any evident relief. It has been proposed and tried in hydrophobia: it apparently mitigated the symptoms. Dr. Hall (Lect. on the Nerv. Syst. p. 155) proposes that in addition to the use of this acid, tracheotomy, as suggested by Mr. Mayo, should be tried.

Hydrocyanic acid has been administered as an anodyne in several painful affections; namely, cancer, tic-douloureux, rhematism, &c., but with a few exceptions, it has not been found serviceable.

As an anthelmintic it has been extolled by Brera; but the following fact mentioned by Dr. Elliotson, will, I imagine, show its true value:—" I have frequently employed it perseveringly without expelling one worm, when a dose of calomel has instantly brought away hundreds."

(b.) External.—The local employment of the acid has not been attended with very great success.

In chronic skin diseases, especially impetigo, prurigo, and psoriasis, the acid has been recommended by Dr. A. T. Thomson to allay pain and irritation. Schneider, of Dusseldorf, has employed 1 ½ drachms of hydrocyanic acid, six ounces of spirit, and as much rose water, in scaly diseases attended with severe itching, especially in eruptions upon the genital organs. On several occasions I have tried hydrocyanic washes in prurigo, but without obtaining any obvious relief. Dr. Elliotson says he has found it efficacious in sores behind the ears, and in scabs of the
hydrocyanic acid.

249

largely certainly o ammonia and most the Gum In wash, this, (viz. The Ammonia. 169). If In state and lilyly these. W.NTIDOTES. As Clips, chlorine and cherry-laurel water, the active prin-

dle of which is this acid. In gonorrhoea, injections containing hydro-

mic acid have been employed with benefit. Schlegel has tried also cherry-laurel water with the same result. Lastly, the dilute acid has en proposed as an effectual and agreeable mode of destroying vermin.

administration.—The best mode of exhibiting this acid internally is the form of mixture. I generally give from three to five minims of the acid in about an ounce of some mild vehicle (simple water answers y well), and repeated three or four times a day. Gum or syrup and the flavouring ingredient (as orange-flower water, used on the continent) y be added. Some persons give it in almond emulsion.

As a wash, two fluidrachms of the dilute acid of the shops may be
ployed mixed with half a pint of distilled (or rose) water as a lotion in diseases. Frequently about half an ounce of rectified sprit is added.

Dr. Thomson recommends, in addition to this, sixteen grains of tate of lead. The external use of this acid, in all cases (more espe-

self if there be sores) requires great caution. Its effects on the nervous tem and on the pulse must be carefully watched. In some cases it ses giddiness and faintness; and Mr. Plumbe says, in two instances it duced intermission of the pulse.

antidotes.—The most important agents in the treatment of poisoning hydrocyanic acid, as well as by the substances which contain it (viz. cherry-laurel, bitter almonds, the volatile oil of these substances, &c.), chlorine, ammonia, cold affusion, and artificial respiration.

1. Chlorine is the most powerful of these. It was first proposed by az in 1822. It has been subsequently strongly recommended by Thner, Simeon, and Orfila. It should be applied both internally and renally if possible. If chlorine water (aqua chlorinii, Ph. D.) be at d, this should be given in doses of one or two tea-spoonfuls properly ted with water. In the absence of this, weak solutions of the chloride me or the chloride of soda may be administered. Nitro-hydrochloric l largely diluted might be given where none of the above agents could procured. The patient should be allowed to inhale, very cautiously, impregnated with chlorine gas (developed by the action of dilute rochloric acid on chloride of lime). Enemata containing chlorine er or a solution of chloride of lime should also be employed.

2. ammonia.—The spirit of sal ammoniac was proposed by Mead hman. Account of Poisons, 5th edit. p. 275, 1756) as an antidote for el water. In 1822, ammonia was recommended by Mr. J. Murray as antidote for hydrocyanic acid; and its value has been admitted by hner, Orfila, Dupuy, and Herbst: but it is certainly inferior to marine; and, therefore, should be used only in the absence of this. If patient be able to swallow, the liquor ammoniac, diluted with eight or parts of water, should be exhibited, and the vapour of ammonia or itsionate inhaled: the latter practice is most important, and should not omitted. Orfila says that ammonia is of no use when introduced into stomach, but that the inhalation of the vapour will sometimes preserve

Great care is requisite in the employment of it (see p. 169). In absence of ammonia the inhalation of the vapour of burnt feathers
might be employed. Ammonia cannot be useful, as an antidote, if its chemical properties merely, since hydrocyanate of ammonia is powerful poison.

(c.) Cold affusion has been strongly recommended by Herbst (*Arch. f. Anat. et Phys.* 1828; quoted by Dr. Christison), and is admitted by Orfila to be a valuable remedy, though he thinks it inferior to chlorin. Herbst says that its efficacy is almost certain when it is employed before the convulsive stage of poisoning is over, and that it is often successful even in the stage of insensibility and paralysis.

(d.) Artificial respiration ought never to be omitted. Of its efficacy am convinced from repeated experiments on animals. I once recovered a rabbit by this means only, after the convulsions had ceased, and the animal was apparently dead. It is an operation easily effected, and will be found a powerful assistant to chlorine or ammonia, by enabling it to get into the lungs when natural respiration is suspended. To produce respiration, make powerful pressure with both hands on the anterior surface of the chest, the diaphragm being at the same time pushed upward by an assistant. Inspiration is effected by the removal of the pressure and the consequent resiliency of the ribs.

Other remedies (as turpentine) have been recommended, but they will not bear comparison (if, indeed, they possess any efficacy) with those here mentioned. Blood-letting has been advised, in vigorous subjects, when respiration has been established, and the skin is livid (Devergie, *MéLég.* t. ii. p. 825).

**Order 8.—Phosphorus and Phosphoric Acid.**

*Phosphorus.—Phosphorus.*

History.—This substance was discovered in 1669, by Brandt, alchymist at Hamburgh; and received its name from being luminous in the dark (from φῶς, light; and φέρω, I carry).

Natural History.—Phosphorus is found in both kingdoms of nature.

(a.) In the inorganized kingdom.—Phosphorus is comparatively rare in the mineral kingdom. Various phosphates are found native, but in small quantities: those of lime, lead, iron, copper, manganese, uranium, yttria, may be mentioned as examples. Phosphate of lime is an important constituent of the organic exuviae entombed in the fossiliferous rocks.

(b.) In the organized kingdom.—Phosphoric acid, free, or combined with lime, potash, or iron, is found in various vegetables (Decandolle, *Ph. Végét.* pp. 383, 387, and 390). Phosphorus is a constituent of animal in some cases it is in combination with oxygen, and a base, as in bones, urine, &c. in other instances, as in the brain, it is uncertain what form it exists.

Preparation.—Phosphorus is procured from bone-ash (sub- or \(\frac{3}{2}\) phosphat of lime), by digesting it in sulphuric acid; by which sulphate of a superphosphate of lime are procured: the first, for the most part, precipitates, while the latter remains in solution. The solution is to be evaporated nearly to dryness, then mixed with charcoal, dried, and distilled in an earthen retort. The charcoal abstracts the oxyg
Phosphorus.

n the phosphoric acid of the superphosphate, setting free the phospho-

Properties.—It is a pale yellow, semitransparent, crystallizable, 

hydrabile combustible solid. Mitscherlich says the crystals are rhombic decahedrons; so that they belong to the regular or tessular system. It is especially violet light, reddens it.

Its sp. gr. is 1.77.—At ordinary temperatures it is flexible, but at 32° brittle. It melts at 105°, and boils at 550° F. It gives off a small quantity of vapour at ordinary temperatures. In the atmosphere its 

aces are luminous in the dark, in consequence of a slow combustion: they have the odour of garlic. By keeping in water, phosphorus becomes 

absorbed by a white substance, by some regarded as an oxide, by others as a hydrate of phosphorus. Phosphorus is insoluble in water, but soluble in ether, and the oils both fixed and volatile. It may be reduced to powder by melting it under water, and shaking in a closed vessel until 

. Its equivalent by weight is 16.

Characteristics.—Phosphorus in substance is easily recognized by its 

vapoury appearance; by its fuming in the air, and being phosphorescent luminous in the dark; by friction or gentle heat causing it to inflame; 

lastly, by its burning with a most intense white light and a white 

luminoes of phosphoric acid. A solution of phosphorus in oil or ether, 

be known by its garlicky odour, and, when rubbed on the skin, by 

rendering the latter luminous in the dark.

Physiological Effects.—(a.) On vegetables.—According to Marcet it is poisonous to plants.

(b.) On animals generally.—Water impregnated with phosphorus, acts 

as an aphrodisiac to drakes (Alph. Leroy, quoted by Bayle, Biblioth. de 

cup. t. ii. p. 28). Phosphuretted oil acts as a stimulant to horses: 

it is drawn from a vein had a phosphoric odour (Pilger, quoted by 

Bayle). If phosphuretted oil be injected into the jugular vein, or into 

the caviety of the pleura of a dog, white vapours of phosphorus are evolved 

in the mouth, and death shortly takes place. The phosphorous acid 

forms the lungs in its passage through the delicate pulmonary vessels. 

duced into the stomach of animals, phosphorus acts as a caustic on. The corrosion is supposed to depend on the action of the 

phosphoric acid (formed by the combination of the phosphorus with the 

gen of the air contained in the alimentary canal) on the tissue with 

ich it is in contact.—(Orfila, Toxicol. Général.)

(c.) On man.—In small doses, phosphorus acts as a powerful and 

visible stimulant, exciting the nervous, vascular, and secreting organs. 

It creates an agreeable feeling of warmth at the epigastrium, increases 

frequency and fulness of the pulse, augments the heat of skin, 

strengthens the mental activity and the muscular powers, and operates as a powerful sudorific and diuretic. Its aphrodisiac operation has been recog- 

ved by Alphonse Leroy, and Bouttatz (Bayle, op. cit.), by experiments 

themseves. In somewhat larger doses it causes burning pain, 

iting and purging, with extreme sensibility of the stomach, which 

for several days (see an experiment made by Sundelin on himself, 

ub. d. Heilm. 2°, Bd. s. 213). In still larger doses, it causes 

mination of the stomach and bowels. Its activity as a caustic 

depends, according to Orfila, on its absorbing oxygen, and thus
becoming converted into an acid which acts as a corrosive, like the oil of mineral acids. Hence, therefore, ethereal and oleaginous solutions are more active poisons, inasmuch as the oxidation of the phosphorus is effected more rapidly. Comparatively small doses have in some cases proved fatal. In Dr. Christison's Treatise on Poisons are references to several cases: in one 1½ grains, in another instance 3 grains, caused death. Cases, however, are reported, in which 6, 10, and even 12 grains have been swallowed without any hurtful effects; but doubts have been entertained as to the correctness of the statements. Thus the authors of the Dictionnaire de Matière Médicale think that the phosphorus employed in these cases must have undergone some chemical change. I once administered 16 grains of phosphorus to a man without any injurious effect, and, judging from its physical characters, I should say the phosphorus was that usually met with in commerce. The man here alluded to by Chabert, some years ago renowned in London under the name of the "Fire King." I carefully weighed out 16 grains, placed them in a spout bottle and put them in his mouth; and he washed them down with a tumful of water. He offered to take this dose daily. How he counteracted the ill effects, I know not; but I suspect he excited vomiting, for within ten minutes after swallowing the phosphorus, he left the room for about a quarter of an hour.

Uses.—In this country, phosphorus is rarely employed, and, therefore, it will be unnecessary to enter minutely into its uses. It has been strongly recommended in those cases attended with great prostration of the vital powers, as in the latter stages of typhus fever, dropsies, &c.; some chronic diseases of the nervous system, as epilepsy, paralysis, melancholy, mania, amaurosis, &c., when these occur in debilitated subjects. In some of the exanthemata, as measles, it has been administered to promote the re-appearance of the eruption when this, from some cause, had receded from the skin; in impotential virills of old and debilitated subjects; in cholera, &c. Paillard recommends phosphorus as an astringent, in the place of moxa, than which, he says, it is more convenient and safer. (Med. Gaz. vol. ii. p. 254).

Administration.—Phosphorus cannot be given with safety in a solid form. It may be administered dissolved in ether, and formulate the preparation of an ethereal solution (tinctura etherea cum phosphorii, Fr. Cod.) will be found in Magendie's Formulaire, and in the Free Codex. But some objections have been raised to its use. It is said that upon the evaporation of the ether the phosphorus will be set free, and may inflame the stomach. A solution of phosphorus in fixed oil (Ole phosphorum, Ph. Boruss.) is, therefore, more commonly employed. Magendie's formula for this is the following:—Digest, during five days, in a dark place, one part by weight of phosphorus, cut in very small pieces, in sixteen parts of olive or almond oil, in a stoppered bottle. To communicate an aromatic flavour, a few drops of the essence of bergamot may be added to the decanted liquid. The solution is termed aromatic phosphorized oil (huile phosphorée aromatisée). Of this oil from 25 to 30 drops may be given in 24 hours: it may be administered in some mucilaginous liquid, or in an emulsion.

Antidotes.—In poisoning by phosphorus, our objects are to prevent or stop the oxidation of the phosphorus, and to neutralize the result
Acid as fast as it is formed. To fulfil the first of these indications, large quantities of mild demulcent liquids are to be exhibited, so as to develop the phosphorus and exclude it from the air contained in the liminary canal. Magnesia should be given, in order to neutralize the phosphorous and phosphoric acids. Parts burned with phosphorus are to be washed with a weak alkaline solution, to remove any adhering acid which might serve to keep up irritation.

Acidum Phosphoricum.—Phosphoric Acid.

History.—Phosphoric acid was first distinguished by Marggraf, in 1740.

Natural History.—(See Phosphorus).

Preparation.—In the London Pharmacopoeia, dilute phosphoric acid (the only official form of phosphoric acid) is ordered to be prepared by adding an ounce of phosphorus to four fluidounces of nitric acid, mixed with ten fluidounces of distilled water, in a glass retort placed in a sand-bath; then apply heat until eight fluidounces are produced. Let these again put into the retort that eight fluidounces may distil, which are to be rejected. Evaporate the remaining liquor in a platinum capsule until only two ounces and six drachms remain. Lastly, add to the acid, when it is cold, as much distilled water as may make it accurately measure twenty-eight fluidounces.

In this process six equivalents or 96 parts of phosphorus react on five equivalents or 270 parts of real nitric acid, and abstract fifteen equivalents or 120 parts of oxygen, with which they form six equivalents or 16 parts of phosphoric acid, while five equivalents or 150 parts of the oxide of nitrogen are evolved.

Ingredients Reacting.  

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<tbody>
<tr>
<td>5 eq. Nitrogen</td>
<td>70</td>
<td>150</td>
<td>6 eq. Phosphoric Acid</td>
<td>216</td>
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<tr>
<td>10 eq. Oxygen</td>
<td>80</td>
<td>15 eq. Oxygen</td>
<td>120</td>
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<tr>
<td>15 eq. Oxygen</td>
<td>90</td>
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If strong nitric acid be employed, instead of the dilute acid ordered in the Pharmacopoeia, the re-action is so energetic that an explosion and combustion are sometimes the consequence. In such cases some nitrate of ammonia is usually developed: the ammonia being formed by the oxidation of the nitrogen of the acid with the hydrogen of the water.

Properties.—The aqueous solution of phosphoric acid (acidum phosphoricum dilutum, Ph. L.) prepared as above, is a colourless and odourless liquid. It possesses the usual characteristics of an acid; that is, it is sour to the taste, reddens litmus, and neutralizes bases. Its sp. gr., according to Mr. Phillips, is 1·064. By evaporation it acquires the con- sistency of treacle (hydrated phosphoric acid); and when exposed to a higher temperature, it loses water and becomes pyrophosphoric acid. A dull red heat a further evolution of water takes place, and a compound formed, called metaphosphoric acid: this is fusible, and by cooling concretises into a transparent solid, called glacial phosphoric acid.

Characteristics.—If phosphoric acid be saturated with an alkali (soda) so as to form a soluble phosphate, it may be distinguished from all
other acids by the following characters: it throws down, with the soluble salts of lime, lead, and baryta, white precipitates (phosphates) soluble in nitric acid: with the nitrate of silver it causes a yellow precipitate (subsesquiphosphate of silver) soluble in nitric acid and in ammonia hydrosulphuric acid causes no change of colour or precipitate with it; if the soluble phosphate be heated to redness, it is converted into a pyrophosphate, which gives, with the nitrate of silver, a white precipitate (pyrophosphate of silver).

PURITY.—Diluted phosphoric acid, prepared according to the Pharmacopeia, generally, if not invariably, contains traces of nitric acid. Sulphuric acid may be recognized by chloride of barium, which produces with it a white precipitate insoluble in nitric acid. Hydrochloric acid is detected by nitrate of silver, which causes a white precipitate also insoluble in nitric acid, but soluble in ammonia. The presence of metallic matter may be known by hydrosulphuric acid. Saturated with carbonate of soda, no phosphate insoluble in water should be thrown down.

Composition.—Pure anhydrous phosphoric acid is thus composed:

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<tbody>
<tr>
<td>Phosphorus</td>
<td>1</td>
<td>16</td>
<td>44·44</td>
<td>44·05</td>
<td>44·8</td>
<td>42</td>
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<tr>
<td>Oxygen</td>
<td>1½</td>
<td>20</td>
<td>55·56</td>
<td>55·95</td>
<td>55·2</td>
<td>57</td>
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Phosphoric Acid 1 36 100·00 100·00 100·0 100

Mr. Phillips says, that 100 grains of the dilute acid of the Pharmacopeia saturate 42 grains of [crystallized] carbonate of soda. If the whole the free acid were phosphoric, the composition of the dilute acid would be as follows:—

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<tr>
<td>Phosphoric Acid</td>
<td></td>
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<td>10·5</td>
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<tr>
<td>Water</td>
<td></td>
<td></td>
<td>89·5</td>
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<tr>
<td>Dilute Phosphoric Acid</td>
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<td>100·0</td>
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Physiological Effects. (a.) On vegetables.—This acid is poisonous to plants (Gœppert, quoted by Decandolle, Phys. Végét.)

(b.) On animals.—Very few experiments have hitherto been made with it on animals. Orfila (Toxicolog. Général) found that a strong solution of it acted like sulphuric acid. Thrown into the veins of a dog, it coagulated the blood and killed the animal within ten minutes. Introduced into the stomach, it acted as a powerfully corrosive poison.

(c.) On man.—Diluted phosphoric acid produces the usual effects of the diluted mineral acids, and which I have before noticed (pp. 80, 81 and 96). It is, therefore, denominated tonic and refrigerant, and may be employed wherever the mineral acids are indicated. It is milder, more assimilable, and, therefore, less likely to disagree with the digestive organs than sulphuric acid, with which, in its action, it is usually compared. These qualities it perhaps derives from its being, as Burdach (Arzneimittellehre, Bd. 3, S. 395, 1809) expresses it, "less heterogeneous to the human organism, since it has a considerable share in the composition of it." The same authority also observes, that besides fulfilling the indications of the mineral acids, "it much exalts the excitability when the organism is weak."
Various effects have been ascribed to this acid, which require to be her investigated ere they are admitted. Thus Hecker (Arzneimittel. ii. S. 305) says, it has a specific operation on the nervous system, in the of which it possesses the power of allaying pain and spasm. Lentin (Beiträge zur anstib. Heilk. Bd. 2. S. 139) considers it to be bowed with a specific power of influencing secreting surfaces and the es, whereby it is enabled to ameliorate various morbid conditions of se parts. Sundelin (Heilmittel, Bd. 2, S. 234) regards it as a stimu- tive and tonic to the sexual organs. Various effects have been ascribed it by Herder (Hufeland's Journ. Bd. 9, St. 3, S. 148).

Uses.—Phosphoric acid has been employed in the same cases in which sulphuric and other mineral acids have been used, and under the regulations. It may be employed for a longer period, without dis- ing the digestive functions, than the other agents of this class.

It has been used in certain cases rather on theoretical than practical ends. Thus its power of dissolving phosphate of lime has led to its employment in those forms of lithiasis attended with phosphatic de- fits in the urine,—in ossification of the arteries and cardiac valves,— in exostosis and other osseous tumours. Lentin used it as a local ent to check caries, from a notion that this disease depends on a defi- nacy of phosphoric acid in the part affected. Woulff applied it to mote the formation of bone.

There are several other diseases against which this acid has been minstered. Thus it has been given in blenorrhœa and leucorrhœa, when secreted fluid was thin and acrid (Sundelin),—in profuse suppurati-, to diminish the quantity and improve the quality of the secreted ter,—in hysterical affections of young and irritable subjects, Sundelin found it useful,—in impotency of the male (Berends),—in diabetes, in jaundice.

Administration.—Internally the dilute phosphoric acid should be en in doses of from ten minims to half a drachm, properly diluted. ed with eight or ten times its volume of water, it may be employed to wash in caries.

Antidotes.—(See Sulphuric Acid.)

Order 9.—Sulphur and its Non-Metallic Compounds.

Sulphur.—Sulphur or Brimstone.

History.—Sulphur has been known from the most remote periods of ity. It is mentioned by Moses (Genesis, xix. 24), Homer (Iliad, xvi.) and other ancient writers.

Natural History.—It is found in both kingdoms of nature.

A. In the inorganized kingdom.—Native or virgin sulphur occurs in two ns: either imbedded in rocks (common native sulphur), or produced by limation (volcanic sulphur). In Sicily it is found in beds in a blue y formation, which, in the opinion of Dr. Daubeney, is more recent n chalk, but is of the same age with the gypsum beds in the neigh- hood of Paris. Solfatara (called by the ancients Forum Vulcani or Court of Vulcan), a kind of half-extinct volcano, in the vicinity of
Naples, is celebrated for its native sulphur, which is collected in considerable quantities for the purposes of commerce. (Sir W. Hamilton, *Campi Phlegraei*, 177.) Sulphur is also found in the mineral kingdom in a state of combination. The sulphurous acid gas rushes out from volcanoes. Sulphuric acid is found native both in the free and combined states: hydro-sulphuric acid gas is evolved from pure sulphurous or hepatic waters, and from the soil in some parts of Italy and other places; lastly, sulphur is found in almost its celebrated sulphates some of which are native in Naples, lighted in 1775, in a pail (3) containing water, when it congeals, and forms the rough or crude sulphur (*sulphur crudum*) (Dumas, *Traité de Chimie*, t. 1*. p. 121).

Crude sulphur is purified in this country. The process formerly adopted was to submit it to fusion in an iron cauldron: the earthly impurities subside, and the liquid sulphur is ladled out and cast into moulds.
the improved method of purifying it is to submit it to distillation in a large cast-iron still: the receiver, which is made of iron, is kept cool by immersion in water. The sulphur obtained by this process is called *fixed sulphur*. When cast in wooden moulds it constitutes *stick, roll, cane sulphur* (*sulphur in baculis, — s. rotundum, — s. in rotulis*). If it be required to obtain the sulphur in a pulverent form, the above process of distillation is modified, thus:—The communication between the still and the iron receiver is shut off, while another is opened with a large chamber sulphur-house, on the walls of which the sulphur condenses in a pulverent mass; in this state it constitutes *sublimed sulphur*, or *flowers of sulphur* (*sulphur sublimatum, seu flores sulphuris*). When washed with water to separate a little adhering acid, it is termed *washed sulphur* (*sulphur lotum*). The method of purifying sulphur adopted at Marseilles, as described by Mmas (*op. cit.*), is somewhat different to that now described, and which have been seen practised in the neighbourhood of London.

(b.) *Decomposition of metallic sulphurets.*—In some places sulphur is obtained by the decomposition of metallic sulphurets (iron or copper). Anglesea it is (or was) prepared by roasting copper pyrites, by which method sulphur is burned, while the remainder is volatilized and collected in chambers connected with the domes of the furnaces by means of horizontal flues (*Aikin's Dict. of Chem.* vol. ii.)

The dregs remaining after the purification of sulphur are called *horse limestone* (*sulphur vivum; sulphur caballinum; sulphur griseum*).

**Properties.**—At common temperatures, pure sulphur is a brittle, crystallizable, yellowish, without smell, and with a very weak and almost imperceptible taste. The specific gravity of ordinary sulphur is about 1·99, but, when free from air-bubbles, 2·087. It is a bad conductor of electricity, and, therefore, by friction becomes perfectly electric. It is a bad conductor of heat, and when grasped in the warm hand crackles, and sometimes breaks to pieces. It is fusible, volatile, and combustible. In atmospheric air it burns with a pale flame, and emits a large quantity of fumes having a peculiar suffocating odour (*sulphurous acid*).

It is called *dimorphous* because it has two distinct primary forms. The primary form of the crystals of native sulphur, or of those deposited from solution in bisulphuret of carbon, is a right rhombic octahedron; while that of the crystals obtained by the fusion and slow cooling of sulphur, is an oblique rhombic prism. Now these two forms are incomparable, and cannot be derived from one of the other: the first belongs to the rectangular or rhombic right prismatic system; the second to the trangular or rhombic oblique prismatic system.

When sulphur is heated to 340°, it becomes viscid; and by increasing heat the viscosity increases, until the temperature arrives at between 360° and 500°. If while in this state it be suddenly cooled, as by throwing it into water, it remains quite soft, so that it may be drawn out into threads. The cause of this change, which seems to be merely physical, is not understood. The atomic weight of sulphur is about 16.

**Characteristics.**—Sulphur is easily distinguished from other bodies, by its colour, its fusibility, its volatility, and its burning with a blue flame, and the evolution of sulphurous acid gas, the odour of which can be easily recognized.

**Impurities.**—Rough sulphur is always mixed with variable quantities
of foreign substances. Vauquelin (Ann. de Chim. 25, 50) distilled 20 grains, and obtained a residuum of 0.82, composed of silica, carbonate of lime, iron, bituminous charcoal, alumina, and magnesia, but the proportion of earthy matters is generally more considerable. Sulphur obtained from pyrites sometimes contains orpiment (sesquisulphuret of arsenicum). The purity of any specimen is determinable by dissolving it in oil of turpentine, which does not act on the foreign matters. It should be perfectly volatile.

Physiological Effects. (a.) On vegetables.—Sulphur does not appear to be injurious to vegetables, for seeds vegetate and produce thriving plants when sown in sulphur.

(b.) On animals.—The veterinary school at Lyons found that a poultice of sulphur killed horses by producing violent inflammation, recognizable during life by the symptoms, and after death by the morbid appearance. (Christison’s Treatise on Poisons.)

(c.) On man.—In small and repeated doses sulphur acts as a gentle stimulant to the secreting organs, especially to the skin and the mucous membranes, (particularly the bronchial membrane). It promotes the capillary circulation of these parts and increases their secretions. Sundelin (Heilmittell. Bd. 1, s. 196) says it operates specifically on the mucous membrane of the rectum, and thereby promotes critical hemorrhoidal secretions. That it becomes absorbed is shown by the odour of hydrosulphuric acid which it communicates to the sweat, urine, and milk, and by silver articles becoming blackened in the pockets of patients who have under the influence of it. By the Germans, sulphur is called a resolving and is ranked with the mercurial and antimonial preparations. (Sundelin, op. cit., and Vogt, Pharmacodyn.) That is, they regard it as an agent powerfully influencing the nutrition of organs, and, therefore, well adapted for ameliorating various disordered conditions, by what usually denominated in this country an alterative action. “From mercurial and antimonial medicines,” says Sundelin, “sulphur is distinguishable by its great diffusibility, in virtue of which it comes near the excitantonic agents [e.g. the carminative fruit of Umbelliferae], and also by not possessing the defluxing (verflüssigenden) properties of these agents.

In larger doses (as one or two drachms) sulphur acts as a mild purgative, without exciting the pulse or occasioning griping. As the stools are usually solid, Dr. Paris (Pharmacologia, vol. i. art. Cathartics) concludes that the action of sulphur on the bowels is confined to the muscular coat.

Uses.—Sulphur is employed both internally and externally.

(a.) Internally.—It is given for various purposes. In affections of the rectum, as stricture, haemorrhoids, and prolapsus, it is a valuable agent as a mild purgative. I have frequently employed it when patients have great disgust for castor oil. In order to promote its purgative effect, will be sometimes necessary to conjoin magnesia or the bitartrate of potash. In chronic cutaneous diseases, more especially prurigo, impetigo, and scabies, the internal use of sulphur is sometimes attended with great benefit. In pulmonary affections, as chronic catarrhs and asthma, it is said to be sometimes useful. In rheumatic and gouty affections also, some have employed it as an anthelmintic. Vogt (op. cit.) employs it as a resolvent in inflammation: as in croup, bronchitis, peripneumonia, and abdominal inflammation. In some constitutional diseases (as scrofula
SULPHUR.

Secondary syphilis) it has been used as an alternative. Tortual has proposed sulphur as a preservative against measles; but, as might be expected, experience shows sulphur possesses no prophylactic power of this kind, and that the only preservative is isolation.

(b) Externally.—Sulphur is a most valuable remedy in various skin diseases, more especially scabies; and notwithstanding many substitutes have been proposed for it in the latter disease, none are so generally successful. It is supposed by some that the curative powers of sulphur in this disease depend on its poisonous influence over the so-called h-insect (Sarcoptes hominis of Raspail, the Acarus Scabiei of other authors): a little parasite belonging to the class Arachnida of articulated animals, and, therefore, improperly termed an insect (Raspail, Mémoire l’Insecte de la Gale, Paris 1834).

Fig. 49.

Sarcoptes hominis—(Raspail.)

Before adopting this explanation of the modus medendi of sulphur, it to be proved that the animal is the cause of the disease: for, at present, it has not been satisfactorily shown whether it be the cause, or mere accompaniment of itch. Rayer (Treatise on Diseases of Skin, by Dr. Willis, p. 344) observes, that it is indubitable that the number of these insects bears no proportion to that of the vesicles. "It further," he adds, "rare to discover these insects on the abdomen and groins, where the eruption of scabies is nevertheless very common and apparent; moreover, scabies is known to continue when no more mites are to be discovered." Besides scabies, sulphur is a most valuable application to various other skin diseases, as porrigo, impetigo, &c.

Administration.—Internally, sulphur is usually given with syrup, or made, in the form of an electuary, or suspended in milk. The dose of sulphur as a purgative, is from one to three or four drachms. As an alternative sudorific, the dose is about half a drachm. The preparation sold under the name of milk of sulphur, or precipitated sulphur, is a more convenient and agreeable preparation for internal use, than the ordinary limed sulphur.

Externally sulphur is principally employed in the form of ointment. Unguentum sulphuris (Ph. L.) consists of three ounces of sulphur to a pound of lard: twenty minims of the oil of bergamot are added
to counteract, in part, the unpleasant odour of sulphur. The unguentum sulphuris compositum is composed of half a pound of sulphur, two ounces of powdered white hellebore, half a pound of soft soap, a pound and a half of lard, and thirty minims of the oil of bergamot: it is a much more irritant application than the simple ointment of sulphur. Both are employed for the cure of itch, and, sometimes also, in the various forms of porrigo which affect the heads of children.

1. Sulphur Precipitatum.—This preparation, commonly termed milk of sulphur (laco sulphuris), was known to Geber. It may be prepared by boiling one part of sublimed sulphur, two parts of slacked lime, and eight parts of water. To the filtered solution add sufficient hydrochloric acid to precipitate the sulphur, which is to be washed and dried.

The theory of the process is the following:—When sulphur and lime are boiled in water, six equivalents or 96 parts of sulphur react on the equivalents or 84 parts of lime, and produce two equivalents or 1 part of bisulphuret of calcium, and one equivalent or 76 parts of its hyposulphite of lime. By the action of three equivalents or 111 parts of hydrochloric acid on these two salts, we obtain three equivalents or 1 part of chloride of calcium, six equivalents or 96 parts of sulphur, a three equivalents or 27 parts of water.

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>FIRST STAGE.</th>
<th>SECOND STAGE.</th>
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<tbody>
<tr>
<td>3 eq. Hydrochl.</td>
<td>3 eq. Hydr.</td>
<td>3 eq. Water,</td>
</tr>
<tr>
<td>Acid 111</td>
<td>2 eq. Chlor. 108.</td>
<td>3 eq. Chlor. Ca</td>
</tr>
<tr>
<td>3 eq. Lime... 84</td>
<td>2 eq. Oxyg. 16</td>
<td>1 eq. Oxyg. 8</td>
</tr>
<tr>
<td>1 eq. Lime... 28</td>
<td>2 eq. Calc. 40</td>
<td>12 eq. Oxyg. 16</td>
</tr>
<tr>
<td>6 eq. Sulphur 96</td>
<td>2 eq. Sulph. 32</td>
<td>2 eq. Sulph. 32</td>
</tr>
<tr>
<td>4 eq. Sulph. 64</td>
<td>2 eq. Bisulph. Calc. 104</td>
<td>2 eq. Calc. 40</td>
</tr>
</tbody>
</table>

Properties.—Precipitated sulphur agrees in most of its properties with sublimed sulphur, but is much whitier, and is in a finely pulverized form. Berzelius says, that when melted, it gives out a little sulphuret of hydrogen; and on cooling, resumes the yellow colour it had before it was boiled with the alkali.

Composition.—It is composed of sulphur with a little water; and hence it is frequently termed hydrate of sulphur. According to Buchner, however, when well dried, it contains hardly a trace of water, and, therefore, any present under ordinary circumstances must be regarded as hygroscopic; so that the term hydrate is hardly applicable to it.

Impurities.—If sulphuric be substituted for hydrochloric acid, in manufacture of this substance, sulphate of lime will be formed, and may be detected volatilizing the sulphur in a crucible, or by solution in oil of turpentine liquor potassae.

The Effects, Uses, and Doses, are the same as those of common sublimed sulphur.

2. Oleum Sulphuratum.—Sulphur is soluble in both volatile and fixed oils, and formulae are still found in some continental works for preparation of pharmaceutical compounds of them. A formula for sulphurated oil is still retained in the Edinburgh Pharmacopoeia, but I have omitted it from the last edition of the London Pharmacopoeia. The preparation was formerly denominated balsam of sulphur.

It is prepared by boiling one part of sublimed sulphur in eight parts of
SULPHURIC ACID.

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The compound thus procured cannot be regarded as a mere solution of sulphur in oil, since the odour of hydrosulphuric acid, which possesses, proves that the oil has undergone partial decomposition: in fact, the heat to which the oil is raised in order to boil it, causes a chemical change.

It is a dark reddish-brown viscid substance, having an extremely unpleasant odour. Its local action is that of an acrid: its remote operation is that of a stimulant, causing thirst and febrile heat. It has been supposed to possess expectorant and diaphoretic properties. It is applied to foul ulcers, and is employed internally in chronic pulmonary affections. The dose of it is from 40 to 50 drops: but its unpleasant taste and smell most preclude its use.

Acidum Sulphuricum.—Sulphuric Acid.

History.—This acid appears to have been known to Geber as early as the seventh century (Thomson's Syst. of Inorg. Chem. vol. ii. p. 29.) In the state in which we usually meet with it in English commerce, it is termed oil of vitriol, or the protohydrate of sulphuric acid.

Natural History.—It is found in both kingdoms of nature.

(a.) In the inorganized kingdom.—It is found in the waters of some volcanic regions, and is evidently produced by the combustion of sulphur. The Rio Vinagre. (Vinegar River), which descends from the volcano of Puracé, in Colombia, to Popayan, has received its name from its acid properties, which it derives from being impregnated with sulphuric and hydrochloric acids (A. de Humboldt, Vues des Cordillères, p. 220).

Issuing from the crater of Mont Ida, in Java, is a river which also contains this acid. Dr. Thomas Thomson (Mineralogy, vol. i. p. 75) states, that in Persia there is an earth so strongly impregnated with it, that it is used by the natives as an acidulous seasoner of food. This author also says (op. cit. p. 77), that there are no less than twenty-seven sulphates (consisting of combinations of sulphuric acid with one or more bases) in the mineral kingdom. The most abundant of these is the sulphate of lime.

(b.) In the organized kingdom.—The sulphates of lime, potash, and soda, have been found in plants (Decandolle, Phys. Végét. p. 390). The sulphates of potash and soda are mentioned by Berzelius (Traité de Chim. 7me, p. 393) as constituents of human urine.

Preparation.—The most improved method of manufacturing oil of vitriol adopted in this country is the following:—Crude sulphur is burned on an iron plate in a furnace, and the gas (sulphurous acid), hereby produced, is conveyed by a pipe or chimney into a leaden cham-
ber, the bottom of which is covered to the extent of four or five inches with water. The furnace door has two apertures to regulate the supply of atmospheric air. After combustion has continued for several hours, an iron pot containing a mixture of the nitrate of potash or soda and of vitriol, is introduced into the furnace, and steam is conveyed into the leaden chamber. So that sulphurous acid, nitric or nitrous acid (generated by the action of the oil of vitriol on the nitrate of potash, and volatilized by the heat produced by the combustion of the sulphur), and steam, are conveyed into the leaden chamber, and by their mutual reaction produce sulphuric acid, which is absorbed by the water at the bottom of the chamber. To prevent loss in the process, the residual gases are conveyed through two other small leaden chambers (also containing water) before they are allowed to escape into the air.

When the liquid in the leaden chamber has acquired a specific gravity of about 1.5, it is conveyed by leaden pipes into rectangular leaden boiler where it is evaporated and concentrated until its sp. gr. is 1.70; but in some manufactories this part of the process is omitted. The final concentration is effected by boiling it down in glass or platinum retorts; the latter, notwithstanding their great cost, are now usually adopted. The price, of course, depends on their size. Mr. Parkes (Chem. Essay vol. i. p. 535) had one which held thirty gallons, and cost about £360.

**Fig. 51.**

Oil of Vitriol Manufactory.

(a) Furnace.
(b) First leaden chamber. — In the manufactory from which the above sketch was made, this chamber was 70 feet long, 20 feet wide, and 20 feet high; but the size varies considerably in different establishments.
(c) Second ditto.
(d) Third ditto.
(e) Steam boiler.
(f) Pipe or chimney of the furnace.
(g) Steam pipe.
(h) Pipe conveying the residual gas from the first to the second leaden chamber.
(i) Pipe conveying the gas not absorbed in the first and second chambers into the third.
(k) Waste pipe conveying the unsorbed gas into the atmosphere.
(l) Man-hole, by which the workmen enter the chamber when the process is not going on.
(m) Pipe for withdrawing a small portion of sulphuric acid from the chamber, in order to ascertain its sp. gr. by the hydrometer.
ut sometimes they are made so large, that they are worth £1000 each.
this apparatus the acid is deprived of a part of its water and some
sulphurous acid, and when it has attained a sufficient degree of concen-
tration, it is drawn off by means of a platinum syphon into carboys.

The theory of the process is the following:—When sulphurous and
nitric acids come in contact, the first loses, the second gains, oxygen,
which sulphuric and nitrous acids are formed. Dry nitrous acid
and sulphurous acid gases undergo no change when mixed; but, if a
little moisture be admitted, re-action takes place, and a crystalline com-
ound, of sulphuric acid, hyponitrous acid, and water, is formed. This,
dropping into water, is immediately decomposed: sulphuric acid is dis-
laved, and the hyponitrous acid is resolved into nitrous acid and binoxide of
nitrogen, which escape with effervescence in a gaseous form. The nitrous
acid thus disengaged, with that produced by the union of the binoxide
with oxygen of the atmosphere, becoming mixed with more sulphurous
acid and water, gives rise to a fresh portion of the crystalline compound.
The part of the nitrous acid is converted by the water present into nitric
acid and binoxide of nitrogen; while another portion loses the whole of
oxygen, by which a little nitrogen gas is disengaged. In oil of vitriol
manufactories the crystalline compound is rarely formed, owing to the
access of aqueous vapour present. Sometimes, however, it is deposited in
the pipe which conveys away the superfluous vapour, as in the instance
mentioned by Dr. Henry (Ann. Phil. vol. xi. new series, p. 368). For
other information respecting the manufacture of sulphuric acid, see the
papers of Gaultier de Claubry, in Ann. de Chim. xlv. 284; and Dict. de
Indust. tom. i. pp. 108, et seq.

The old method of manufacturing oil of vitriol, and, indeed, one still
allowed in some places, consists in burning a mixture of eight parts of
sulphur and one part of nitrate of potash (or nitrate of soda) on iron or
leaden plates, either within the leaden chamber or in a furnace on the
outside of it (Parkes’s Chemical Essays, vol. i. 465). Fig. 51 is the ground
plan of a manufactory of this kind. Iron pyrites (bisulphuret of iron) is
sometimes substituted for sulphur.

In this process the greater part of the sulphur combines with oxygen of
the air to form sulphurous acid: but a portion abstracts oxygen from the
nitric acid of the nitrate, and thereby becomes sulphuric acid, which, with
the potash of the nitre, forms sulphate of potash. Binoxide of nitrogen is
evolved by the decomposed nitric acid, and this, combining with oxygen
of the air, becomes nitrous acid. The mutual action of sulphurous and
nitrous acid gases has been before explained.

At Goslar, Nordhausen, and other parts of Saxony, sulphuric acid is
made thus:—Crystallized sulphate of iron is calcined, by which the greater
portion of its water of crystallization is expelled. It is then distilled in
artesian vessels, by which fuming sulphuric acid is procured, while sesqui-

**Plan of a Sulphuric Acid Manufactory.**

A. Rectangular leaden boilers.
B, Leaden chambers.
C. Retort house.
D. Leaden pump for acid.
E. Water pump.
oxide of iron is left in the retort. If this acid be heated in a glass retort, it yields real or anhydrous sulphuric acid.

Properties. (a) Of anhydrous sulphuric acid.—It is a crystalline solid, having very much the appearance of asbestos. It gives out dense white fumes in the air, like fluoride of boron. It melts at 66° F. and boils at from 104° to 122° F. The sp. gr. of the liquid acid, at 78° F is 1.97.

(b) Of the Nordhausen or fuming sulphuric acid.—This is usually a dark brown oily-liquid, which gives out copious white fumes in the air. Its sp. gr. is about 1.9. It is imported in stone bottles, having a stoneware screw for a stopper.

(c) Of oil of vitriol or English sulphuric acid.—When pure it is a colourless, transparent, inodorous, highly acid, and corrosive liquid. It possesses the usual properties of a powerful mineral acid in a very eminent degree, such as reddening the vegetable blues, saturating bases and displacing other acids. Its affinity for water is most intense, and by virtue of this, it absorbs aqueous vapour from the atmosphere, and changes animal and vegetable substances. When mixed with water there is a mutual condensation with the evolution of heat. Various substances when heated in sulphuric acid decompose it; they abstract oxygen and evolve sulphurous acid. This is the case with charcoal, organic substances, phosphorus, sulphur, and several of the metals, as copper, tin, and mercury.

The sp. gr. of this acid at 60° F. is about 1.84. Genuine commercial acid should never surpass 1.8455; when it is denser, we may infer sophistication or negligence in the manufacture (Brande's Man. of Chemistry). Acid of sp. gr. 1.845 freezes at — 15° F. and boils at 620° F. In commerce the acid has frequently a sp. gr. of only 1.8433, and its boiling point is 545° F. (Phillips's Transl.)

Composition.—Pure or anhydrous sulphuric acid is thus composed:

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</thead>
<tbody>
<tr>
<td>Sulfur</td>
<td>1</td>
<td>16</td>
<td>40</td>
<td>40-14</td>
<td>Sulphurous acid gas</td>
</tr>
<tr>
<td>Oxygen</td>
<td>3</td>
<td>24</td>
<td>60</td>
<td>59-86</td>
<td>Oxygen gas</td>
</tr>
</tbody>
</table>

| Sulfuric acid | 40 | 100 | 100-00 | Sulphuric acid vapour | 1 | 2.777 |

The composition of oil of vitriol or English sulphuric acid is as follows:

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</tr>
</thead>
<tbody>
<tr>
<td>Real sulphuric acid</td>
<td>1</td>
<td>40</td>
<td>81-6</td>
<td>Commercial (sp. gr. 1.8433).</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>18-4</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

Oil of vitriol | 1 | 49 | 100-0 | 1 | 51-25 | 100 |

According to this statement the strongest oil of vitriol which can be procured (sp. gr. 1.845) is the protohydrate of sulphuric acid, while that met with in commerce is a \( \frac{3}{2} \) hydrate of sulphuric acid.

The German or Nordhausen sulphuric acid consists of—

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<tbody>
<tr>
<td>Real sulphuric acid</td>
<td>2</td>
<td>80</td>
<td>89-887</td>
<td>5</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>10-115</td>
<td>4</td>
</tr>
</tbody>
</table>

Nordhausen sulphuric acid | 1 | 89 | 99-99 |
CHARACTERISTICS.—Free sulphuric acid or the soluble sulphates are cognized by a solution of any of the barytic salts, which throws down a very white precipitate (sulphate of baryta) insoluble in acids or alkalies. This precipitate (or any insoluble sulphate) be ignited with charcoal, it decomposed and converted into a sulphuret, which, on the addition of chloric acid, evolves hydrosulphuric acid, known by its odour and blackening paper moistened with acetate of lead. If sulphuric acid heated with organic matter, sulphurous acid is given out: this may be own by its odour, and by its occasioning the formation of the blue side of starch when mixed with iodic acid and starch.

To determine whether sulphuric acid is free or combined with a base, Christison (Treatise on Poisons, 3d ed. p. 142) recommends the aid to be boiled with pure carbonate of lead. If any free sulphuric acid be present sulphate of lead will be formed, which, being insoluble dilute nitric acid, may be thereby distinguished from carbonate of lead. At this test is liable to objection: alum and other supersulphates re-act carbonate of lead like free sulphuric acid; and, furthermore, sulphate ammonia is decomposed at a boiling temperature by carbonate of lead.

IMPARTIES.—Pure sulphuric acid should be colourless: the presence organic matter, as cork, communicates a brownish or black colour. The acid of commerce usually contains traces of sulphate of lead: may be detected either by adding water, when the white sulphate is precipitated; or by the addition of hydrosulphuric acid to dilute sulphuric acid, when a very slight change of colour is observed, owing to the formation of sulphuret of lead. “What remains of the acid has been distilled to dryness does not exceed the \( \frac{1}{4} \) part of its weight.” — (Ph. Lond.) The residuum here referred to is sulphate of lead.

PHYSIOLOGICAL EFFECTS. (a.) On vegetables.—In the concentrated state sulphuric acid chars the parts of plants to which it is applied. In the mute form it destroys vegetables in a few hours (Marcet, in Decandolle’s Phys. Végét. p. 1345).

(b.) On animals generally.—The action of sulphuric acid on animals generally is precisely the same as that on man. Thrown into the veins a dog, Orfila found that it coagulated the blood, and caused immediate death.—(Toxicol. Génér.)

(c.) On man.—Properly diluted and administered in small but repeated doses, sulphuric acid acts as a tonic and refrigerant, like the other mineral acids (see pp. 80, 84, 96). Thus it promotes the appetite, diminishes desire heat, allays excessive thirst, checks profuse sweating, and, not frequently, reduces the frequency of the pulse. Sometimes it increases secretion of urine, and likewise renders this fluid unusually acid. Under its use the milk frequently acquires a griping quality.

The continued use of it, however, generates a slow kind of gastro-enteritis: heat and pain are experienced in the throat, stomach, and intestines; the digestive functions become disordered; gripings are experienced; sometimes purging, and subsequently fever. Of all the mineral acids, save the phosphoric, this may be administered for the longest period without occasioning the above symptoms.

Concentrated sulphuric acid acts as an energetic caustic poison, empytely disorganizing the different tissues with which it is brought in contact. Its chemical action depends principally on its affinity for
water, so that it chars or carbonizes the parts with which it is placed in contact. But its power of coagulating albuminous liquids, of combining with albumen to form a sulphate of this organic substance, and of dissolving fibrin, as well as coagulated albumen, contribute to its energetic escharotic action on the animal tissues. The parts to which the acid is applied become, in the first place, white; but by the more prolonged action of the poison, they assume a brownish or blackish appearance, so that we can thereby frequently distinguish poisoning by this from poisoning by nitric acid; since this last-mentioned agent produces a yellow colour when applied to the skin. Black spots are frequently observed in the stomachs of those who have swallowed the acid; and in the surrounding parts the blood is usually coagulated in the blood-vessels. Such are the topical chemical effects of this acid. But besides these there are other phenomena of a local nature which may be denominated vital, since they depend on the re-action of the living parts. I refer now to the acute inflammation set up in the tissues in the immediate neighbourhood of those destroyed.

When strong sulphuric acid has been swallowed the symptoms poisoning are the following:—Alteration, or even destruction, of the soft parts about the mouth; burning pain in the throat, stomach, and bowel; frequently alteration of the voice, from the swelling and disorganization of the parts about the larynx; breath fetid, from the decomposed tissues constant and abundant vomiting of matters, which may be bloody otherwise, but which effervesce by falling on a marble hearth; bowels variously affected, sometimes constipated, though usually purged, the stools being bloody. The constitutional symptoms are principally those arising from a disordered action of the vascular system: thus the pulse frequent and irregular, feeble, often imperceptible; extremities cold, great feebleness, or even fainting, with cold sweats. The same constitutional symptoms are observed when the stomach is wounded or ruptured. One remarkable characteristic is, that the mental faculties are unaffected even up to a few minutes before death.

Uses.—1. Medicinal. (a.) Internal.—In febrile diseases it may be administered, largely diluted, as a refrigerant, to diminish thirst and perennial heat; though, in most of these cases the vegetable acids are to be preferred. In the latter stage of fever (especially the kinds called typhoid) considerable benefit is sometimes gained by the use of a vegetable bitter (as calumba or cinchona) in combination with the dilute sulphuric acid. To assist the appetite and promote digestion, it administered to patients recovering from fever. To check profuse sweating in pulmonary and other affections, whether phthisical or not, it sometimes a valuable agent, as I have found on many occasions. No other remedy is so efficacious in relieving colliquative sweatings as this. In hemorrhages, as those from the nose, lungs, stomach, and uterus, it is commonly administered as an astringent, but its efficacy is doubtful; also in purpura haemorrhagica it is given with the same intention; though I have several times employed it, I have not observed any evident benefit derived therefrom.

In those forms of lithiasis attended with phosphatic sediments in urine, the use of the mineral acids is at times beneficial. The sulphur is preferred to the hydrochloric acid, since it can be continued for longer period without occasioning gastric disorder. In skin disease
SULPHURIC ACID.

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...lentine and chronic nettle-rash, it is sometimes serviceable.

those forms of dyspepsia connected with an alkaline condition of the

omach, as in pyrosis, the sulphuric has been found to succeed better

an hydrochloric acid (Dr. R. D. Thomson, British Annals of Med.

March 31, 1837).

(b) External.—As a local agent, sulphuric acid is employed as a

caustic, irritant, or astringent. As a caustic it has no advantage

over many other agents, except that which arises from its liquid form,

which, in most cases, renders it disadvantageous. For example, the

difficulty of localizing it would be an objection to its employment in the

reduction of an issue, but would be an advantage in applying it to

ulcers caused by rabid animals or poisonous serpents, since the liq-

uidy of the acid enables it to penetrate into all parts of the bites. In

ectropium, or that disease in which the eyelid is inverted, or turned

wards upon the eye, this acid has been applied as a caustic. In this

complaint the friction of the eyelashes on the globe is most distressing,

owing rise not only to inflammation, but even ulceration of the cornea.

ow, when the disease is permanent, two modes of curing it have been

reposed; either to remove a fold of the integument by the knife, so

that, by the subsequent cicatrization, the lid may be drawn outwards—

to destroy a portion of the skin by a caustic, as sulphuric acid. The

better plan of treatment has been practised successfully by several emi-

inent oculists, among whom I may name Mr. Guthrie and Mr. Lawrence.

also in ectropium, in which the lid is everted or turned outward, Mr.

Guthrie has applied the concentrated acid to the inner side of the everted

lid with advantage.

An ointment containing sulphuric acid has been employed as a

beefacient in paralysis, and in the second stage of inflammation of the

ints, when the violence of the disease has subsided; as a styptic to

ulcers, to suppress hemorrhage from numerous small vessels; and as a

cura for scabies. Lastly, this acid, properly diluted, is employed as an

astringent gargle in ulcerations of the mouth and throat; but after using

the mouth should be well rinsed, to prevent the action of the acid on

e teeth.

2. PHARMACEUTICAL.—Sulphuric acid is used in the manufacture

of various preparations contained in the Pharmacopœia, as some of the

iods, ether, the vegetable alkalies, several salts, &c.

ADMINISTRATION.—For internal use we generally make use of the

bated sulphuric acid of the Pharmacopœia, or the elixir of vitriol.

1. Acidum Sulphuricum Dilutum.—This compound is pre-

ed by adding, gradually, a fluidounce and a half of sulphuric acid to

teen fluidounces and a half of distilled water. Condensation ensues,

ad heat is evolved. Mr. Phillips states, that a fluidrachm of it con-

ins about ten grains of the strong acid, and will saturate 28 grains of

ystallized carbonate of soda. The dose of it is from ten to thirty

ins diluted with two or three table spoonfuls of some mild liquid.

most convenient preparation of it is the compound infusion of roses,

is sometimes given with conserve of roses.

2. Acidum Sulphuricum Aromaticum.—This preparation, which

contained in the Edinburgh, Dublin, and United States Pharmacoe-

ias, is known in the shops as elixir of vitriol. The Dublin formula

it is the following:—" Take of rectified spirit two pints, sulphuric
acid (by weight) six ounces. Add the acid to the spirit gradually: digest the mixture in a closed vessel, with an inferior heat, for three days, then add of cinnamon bark (bruised) an ounce and a half, ginger root (bruised) an ounce. Digest the mixture again for six days; and, lastly, filter through paper placed in a glass funnel.” An analogous preparation, but containing a much greater number of aromatics, is contained in the French Codex, under the name of tintactura aromatica sulfurica. It has been usually supposed that some sulphuric ether was generated in this preparation, but the late Dr. Duncan observes—“I have ascertained that there is no reaction upon the sulphuric acid, at least that no particle of gas is evolved by the mixture of alcohol and sulphuric acid in the proportions indicated.” It is not improbable that some sulphovinaic acid may be formed: the evolution of gas is not essential to the formation either of this compound or of ether. Elixir of vitriol is used in the same cases and doses as the dilute sulphuric acid.

3. Unguentum Acidì Sulphurici (Ph. Dub.)—This compound is prepared by mixing, in a glass or earthenware mortar, a drachm of sulphuric acid with an ounce of lard. The mixture is of a slight but colour. It is a powerful stimulant.

Antidotes.—In cases of poisoning by sulphuric acid, the antidotes are, chalk, whiting, or magnesia suspended in water. In the absence of these, soap-suds, infusion of wood-ashes, weak solutions of the alkaline carbonates, white of eggs, gelatine, milk, oil, or in fact any mild diluent should be instantly administered. The subsequent treatment is that for gastro-enteritis. External parts burnt with oil of vitriol should be washed with a solution of soap or simple water.

Ac'idum Sulphuro'sum.—Sulphurous Acid.

History.—Homer (Iliad, xvi.) mentions sulphur fumigations: Stahl, Scheele, and Priestley, were the first to submit this acid to an accurate examination. It has been termed volatile sulphurous acid, and, from the old mode of procuring it, spirit of sulphur by the bell (spiritus sulphuri per campanam).

Natural History.—It escapes from the earth, in a gaseous form, in the neighbourhood of volcanoes.

Preparation.—For chemical purposes it is prepared by mixing two parts of mercury with three parts of strong sulphuric acid, applying heat, and collecting over mercury. The results are, the bipersulphate of mercury and sulphurous acid.

For medical purposes, however, it is rarely, if ever, necessary to procure it in this way. By the combustion of sulphur in atmospheric air this gas is readily obtained; and when we are about to employ it, either as a disinfectant or vapour bath, this method is always followed.

Properties.—At ordinary temperatures and pressures it is a colourless and transparent gas, and has a remarkable and well-known odour. It is neither combustible nor a supporter of combustion. It reddens litmus and bleaches some colouring matters, especially infusion of roses, but the colour is restored by sulphuric acid. It is irrespirable, and has a sp. gr. of 2.2. It readily dissolves in water; recently boiled water take up 33 times its volume of this gas. By cold and pressure, sulphuric acid gas is readily condensed into a limpid liquid.
CHARACTERISTICS.—This acid is readily known by its peculiar odour (that of burning sulphur). If the puce-coloured or binoxide of lead be added to it, the white protosulphate of lead is formed. An aqueous solution of this acid, mixed with iodie acid, deoxidizes the latter, and in the iodine free, which may be recognized by its producing a blue colour with starch. The sulphates evolve sulphurous acid by the action of strong sulphuric acid.

Composition.—If 16 parts (by weight) of sulphur be burned in one volume or 16 parts (by weight) of oxygen gas, we obtain one volume or 32 parts (by weight) of sulphurous acid gas.

The composition of this substance may, therefore, be thus expressed:

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Sulphur</td>
<td>1</td>
<td>16</td>
<td>50</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>16</td>
<td>50</td>
</tr>
</tbody>
</table>

| Sulphurous Acid | 1 | 32 | 100 | 100.000 |

Physiological Effects. (a.) On vegetables.—It is a most powerful poison to plants even in very minute quantities (Christison, On Poisons, p. 750).

(b.) On animals generally.—The effects on animals have not been examined; but they are probably those of an irritant and an asphyxiating agent.

(c.) On man.—Applied to the skin this acid gas causes heat, pain, and swelling. If an attempt be made to inhale it in the pure state, it excites aspasm of the glottis. Diluted with air it may be taken into the lungs, and there acts as a local irritant, causing cough, heat, and pain.

Uses.—It has been used as a disinfectant, as a remedy for the cure of itch, and as a nasal stimulant in syncope.

As a disinfectant it is mentioned by Homer. The mode of using it for this purpose is very simple. A pot containing burning sulphur is intro-
uced into the room or place to be fumigated, and the doors and windows carefully closed.

As a remedy for itch, baths of sulphurous acid gas are mentioned by Lauber in 1659. They are commonly termed sulphur baths, and may have been at most of the bathing establishments of the principal towns of this country. At the Hopital St. Louis, in Paris, a very complete apparatus for the application of this remedy in diseases of the skin has been erected by D'Arcet. It is a kind of box, inclosing the whole body, with the exception of the head. The sulphur is placed on a heated plate in the lower part of the box. From ten to twenty baths, or even more, are requisite for the cure of itch. "Sulphurous fumigations," says Rayer (treatise on Diseases of the Skin, by Dr. Willis, p. 347), "which are employed in some hospitals, are not attended with expense, leave no pleasant smell, and do not soil the linen; but the long continuance of a treatment necessary to relieve the disease, more than counterbalances generally insignificant recommendations." There are various other diseases of the skin in which baths of sulphurous acid have been found more or less successful, such as chronic eczema, lepra, psoriasis, impetigo, and pityriasis. (For further information on this subject, consult...

As a stimulant in syncope or asphyxia this gas has been recommended by Nysten. It is readily applied by holding a burning sulphur match under the nose.

Antidotes.—When sulphurous acid gas has been inhaled, the patient should be made to respire the vapour of ammonia. A few drops of the solution of this substance should be swallowed.

**Iodidum Sulphuris.—Iodide of Sulphur.**

**History.**—This compound was first described by Gay-Lussac (Ann de Chimie, xcl.)

**Preparation.**—It is prepared by heating gently four parts of sulphur with one part of iodine. Part of the iodine volatilizes, and the remainder unites with the sulphur.

**Properties.**—It is a black crystallizable compound, having the colour and radiated appearance of sesquisulphuret of antimony. It has the odour of iodine, and stains the cuticle, paper, &c. like this substance. Its elements are easily separated by heat.

**Composition.**—Its composition has not been determined. It is probably the following:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine</td>
<td>1</td>
<td>126</td>
<td>88.732</td>
</tr>
<tr>
<td>Sulphur</td>
<td>1</td>
<td>16</td>
<td>11.267</td>
</tr>
<tr>
<td>Iodide of sulphur</td>
<td>1</td>
<td>142</td>
<td>99.999</td>
</tr>
</tbody>
</table>

**Characteristics.**—Boiled in water the iodine volatilizes, with the steam, and the sulphur is deposited nearly in a state of purity.

**Physiological Effects. (a.) On animals.**—Dr. Cogswell (Experim. Essay on Iodine and its Compounds) gave three drachms to a bitch: the animal lost her appetite, was dull, and on the fourth day could not support herself properly upon her legs. On the twelfth day she was well.

(b.) On man. —It has not been exhibited internally. It probably operates like iodine. Its local operation is that of a powerful stimulant and resolvent.

**Uses.**—Iodide of sulphur has been principally employed, in the form of ointment, in various skin diseases. In lupus it has been found most efficacious by Biett (Cazenove and Schedel, Abrégé pratiq. sur les Maladies de la Peau), as well as by Rayer (Treatise on Diseases of the Skin, translated by Dr. Willis.) The last mentioned writer places it in the foremost rank of local remedies for this disease. In acne indurata and rosacea has proved highly useful in the hands of Biett (op. cit.), Rayer (op. cit. p. 476), and Dr. Copland (Dict. of Pract. Med. art. Acne, p. 31). In lepra Rayer has observed good effects from its use; but in one case in which tried it, it caused so much irritation that its use was obliged to be discontinued. In herpes pustulosus labialis it has been employed with great success by Dr. Volhnar (Dierbach, die neuesten Entdeck in d. Mat. Med. 2te. Ausg. 1er B. S. 449). In tinea capitis it has also been recommended (Med. Gaz. vol. xx. p. 879).

Dr. Copland (op. cit. art. Asthma, p. 149) has employed the inhalation
the vapour of this substance in humoral asthma with temporary vantage.

**ADMINISTRATION.**—The **ointment of iodide of sulphur** is composed of fide of sulphur and lard. The proportions vary according to circumstances: usually from 10 to 30 grains of the iodide to an ounce of lard. Ingenie’s formulae are 1 part of iodide to 18 or 19 of lard.

**Ammo’niae Hydrosulph’phas.**—**Hydrosulphate of Ammo’nia.**

**HISTORY AND SYNONYMES.**—This compound is said to have been first prepared in the seventeenth century by Boyle or Beguin: hence the **Boyle’s fuming liquor** and **Beguin’s sulphuretted spirit**, applied to a variety of it. The ordinary designation of it is **hydrosulphuret of monia**, or **hepatized ammonia**. Berzelius calls it **sulphuret of ammo’nia**.

**NATURAL HISTORY.**—It is evolved from decomposing animal matter, in privies, with hydrosulphuric acid and nitrogen.

**PREPARATION.**—It is prepared, according to the Edinburgh, Dublin, United States Pharmacopoeias, by passing hydrosulphuric acid gas (sulphuretted hydrogen) into water of ammonia to perfect saturation.

**PROPERTIES.**—As thus prepared the solution of hydrosulphuret of monia is a liquid, having a greenish yellow colour, a very foetid odour, an acid disagreeable taste. The mineral acids decompose it, evolve thiosulphuric acid, and precipitate sulphur. A considerable number of metallic solutions have precipitates produced in them by the addition of thiosulphate of ammonia. Thus with the salts of lead, bismuth, silver, and copper, the precipitates are blackish; with those of antimony, arsenic, cadmium and tin (persalts), and with the arsenites the addition of an acid), yellow; lastly, with the salts of zinc, etc. In all these cases the precipitates are sulphurcuits of the respective metals.

By exposure to the air it attracts oxygen and deposits sulphur: its action on metallic solutions is then considerably modified. For example, two or three fluiddrachms be exposed to the air, in a wine-glass, for a day or two, the solution will then be found to have the property of losing a red precipitate with the salts of lead, yellow with tartaric, and white with arsenious acid.

**CHARACTERISTICS.**—Its odour will readily distinguish it. As a sulphuret or hydrosulphuret it is known by its action on the metallic solutions already noticed. Caustic potash causes the evolution of ammonia.

**COMPOSITION.**—It is composed of hydrosulphuric acid and ammonia, the following proportions:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Rosulphuric Acid</td>
<td>1</td>
<td>17</td>
<td>50:00</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>17</td>
<td>50:00</td>
</tr>
<tr>
<td>Rosulphate of Ammonia</td>
<td>1</td>
<td>34</td>
<td>100:00</td>
</tr>
</tbody>
</table>

The fuming liquor (**liquor fumans Boylei**) obtained by distilling four ts of slacked lime, two of hydrochlorate of ammonia, and one of sul-
PHYSIOLOGICAL EFFECTS. (a.) On vegetables.—The vapour of the compound is injurious to vegetation.

(b.) On animals.—I am unacquainted with any experiments made with it on animals; but analogy leads us to believe that its action is that of a powerful poison, analogous to other alkaline sulphures, and hydrosulphuric acid.

(c.) On man.—In small but repeated doses it acts powerfully on the secreting organs, the action of which it promotes, but at the same time modifies. Its principal influence is directed to the skin (on which it acts as a sudorific), and to the pulmonary mucous membrane. In somewhat larger doses it occasions nausea and giddiness. In still larger doses it causes nausea, vomiting, diminished frequency of pulse, giddiness, extreme languor, drowsiness, and sleep. Excessive doses would, course, produce death, though I am unacquainted with any case of the kind.

In the gaseous state it acts, when inhaled, as a powerfully asphyxiatory agent. Instances of its deleterious operation, in conjunction with hydrosulphuric acid, have occurred in France, in workmen exposed the vapours from the pits of the necessaries. The symptoms are, sudden weakness, insensibility, and death; or where the vapours are less concentrated, there are sometimes delirium and convulsions.

USES.—In this country it has been principally employed in diabet. mellitus, with the view of reducing the morbid appetite and increasing action of the stomach, as well of the system in general (Rollo, on Diabet. Mellitus, p. 28, ed. 2nd). Combined with alcohol, F. Hoffmann administered it under the name of liquor anti-podagricus, as a powerful sudorific in gout. It has also been used in old pulmonary catarrhs; and Braun and Gruithuisen in vesical catarrh (Vogt, Pharmakodyn.)

ADMINISTRATION.—It is given in doses of from four to six drops, some proper vehicle (distilled water is the best). On account of its speedy decomposition, it should be dropped from the bottle at the time using it.

ANTIDOTES.—The antidotes for hydrosulphate of ammonia, as well for hydrosulphuric acid, are chlorine and the chlorides of lime and soda. In cases of asphyxia by the inhalation of these substances, the treatment consists in placing the patient on his back in the open air, with his head somewhat elevated; applying cold affusion to the face and breast; producing artificial respiration of air, through which chlorine is diffused, by pressing down the ribs and forcing up the diaphragm, and then suddenly removing the pressure; using strong friction in the course of the vertebral column, chest, soles of the feet, &c., and injecting into the stomach, stimulants; as, a weak solution of chlorine (or chloride of lime) or brandy, &c. In the event of hydrosulphuric ammonia being by accident swallowed in poisonous doses, dilute solutions of chlorine, or of the chlorides of lime or soda, should be immediately given, and the contents of the stomach removed by the stomach pump as soon as possible.
ORDER 10. COMPOUNDS OF POTASSIUM.

Potas'sa.—Pot'ash.

History.—Caustic alkaline solutions were probably known to the Greeks and Romans. We learn from Pliny (Hist. Nat. lib. xxviii. cap. ii.), that soap was made in his time from tallow and wood-ashes; and we may therefore conclude that some method was known of depriving the alkaline carbonate of its carbonic acid. Geber (Invention of Verity, ch. iv.) describes the method of making caustic alkali. Black, however, in the ear 1756, first distinguished, chemically, the caustic alkalies from their carbonates. Potash was formerly called kali, or the vegetable alkali.

Natural History.—Potash in combination with acids is found in both kingdoms of nature.

(a) In the inorganized kingdom.—Potash is found, in the mineral kingdom, in combination with sulphuric, nitric, silicic, and perhaps carbonic acids. As an ingredient of rocks, it is more abundant than soda.

(b) In the organized kingdom.—In organized beings potash is met with in combination with phosphoric, sulphuric, nitric, carbonic, and various organic acids. It occurs more abundantly in vegetables than in animals.

Preparation. (a) Of aquæ potassæ.—To prepare a solution of caustic potash, add fresh burned lime to a solution of the carbonate of potash. In the London Pharmacopœia the proportions employed in the manufacture of liquor potassæ are fifteen ounces of the carbonate, eight ounces of lime, and a gallon of boiling distilled water. The lime, when slacked and mixed with half a gallon of water, is to be added to the carbonate of potash dissolved in the remaining half gallon of water. The mixture is to be kept in a close vessel, and frequently shaken. When cold, the pernament clear liquor is to be poured off: this is the liquor potassæ of the Pharmacopœia.

In this process the lime abstracts carbonic acid from the carbonate of potash, and the potash thus set free dissolves in the water.

Reagents.

<table>
<thead>
<tr>
<th>Water</th>
<th>q. Carb. Potash</th>
<th>q. Lime</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>RESULTS.</th>
<th>Liquor Potassæ (Ph. L.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Potash</td>
<td>1 eq. Carbonate, Aé. 22</td>
</tr>
<tr>
<td>70</td>
<td>28</td>
</tr>
</tbody>
</table>

The best is to avoid filtering the liquid, but to decant it. If, however, a filter be employed, it should be of cotton or linen, and the atmospheric air should be, as much as possible, excluded; as the solution readily composes paper and woollen cloth, and abstracts carbonic acid from the air.

(b) Of hydrate of potash.—If liquor potassæ be evaporated to dryness in a clean iron vessel, and the residual mass fused and poured into moulds, you obtain the hydrate of potash of the Pharmacopœia, and which was formerly called potassæ fusæ, kali purum, lapis infernalis sive septicus, or infernum potentiale.

(c) Of potash with lime.—To render the potash less deliquescent it is mixed with an equal weight of lime, by which it is procured the mixture named potassæ cum calc.

Properties. (a) Of hydrate of potash.—The solid sold in the shops—
as potassa fusa, or hydrate of potash, is usually more or less coloured (brownish, greyish, or bluish), and not completely soluble in water and alcohol, in consequence of the presence of foreign matters; for pure hydrate of potash is white, and dissolves in both water and alcohol. During the solution in water heat is evolved. Its solubility in alcohol enables us to separate it from the carbonate and bicarbonate of potash both of which are insoluble in this liquid. It has a strong affinity for water, which it rapidly attracts from the atmosphere, and in consequence becomes liquid. At a low red heat it fuses, and at a higher temperature is volatilized. It is odourless, but has a caustic, urinous taste. It rapidly decomposes organic substances. It possesses the properties of an alkali in an eminent degree.

(b.) Of liquor potassae.—This liquid is limpid, colourless, transparent and inodorous. Its taste is acid: when prepared according to the London Pharmacopoeia, its sp. gr. is 1·063. It has a soapy feel when rubbed between the fingers. It strongly attracts carbonic acid from the atmosphere, and, therefore, should be kept in close vessels. It corrodes glass, and is, on that account, directed to be kept in green glass bottles.

Characteristics.—Potash free or combined is recognized by the following characters:—The hydrosulphurets, ferrocyanides, and carbonate produce no precipitate with it. Tartaric (in excess), perchloric, and carbazotic acids, occasion precipitates of the bitartrate, perchlorate, and carbazotate of potash respectively. Chloride of platinum throws down yellow precipitate with potash or its salts. Lastly, the potash sal communicate a violet tinge to the flame of alcohol.

The causticity of potash is shewn by its communicating a green colour to the infusion of red cabbage or syrup of violets; by its reddening turmeric, and restoring the blue colour of litmus reddened by an acid by its not whitening lime water, or effervescing on the addition of an acid by its soapy feel; by its solubility in alcohol; and by its dissolvin alumina.

Impurities.—Liquor potassae usually contains a small quantity of carbonate of potash. This may be recognized either by lime-water which renders the liquid turbid, or by a dilute mineral acid, which causes effervescence. When pure liquor potassae has been saturated with nitric acid it gives no precipitate on the addition of carbonate of soda, chloride of barium, or nitrate silver: if the first cause a precipitate it would indicate some earthly or metallic impregnation; if there be a precipitate with the second, which is insoluble in nitric acid, we infer the presence of sulphate; if the third cause a precipitate, soluble in ammonia, but insoluble in nitric acid, a chloride is present.

Potassa fusa of the shops contains various impurities, such as sesquioxide of iron, carbonate of potash, and silica. These, however, do not materially affect its medicinal value, and will not, therefore, require further notice.

Composition.—Pure anhydrous potash has the following composition:—

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>1</td>
<td>40</td>
<td>83·34</td>
<td>83·05</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>16·66</td>
<td>16·95</td>
</tr>
</tbody>
</table>

Potash       | 1   | 48      | 100·00    | 100·00     |
The hydrate of potash is thus composed:

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<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>84·2</td>
<td>84</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>15·8</td>
<td>16</td>
</tr>
<tr>
<td>Hydrate of Potash</td>
<td>1</td>
<td>57</td>
<td>100·0</td>
<td>100</td>
</tr>
</tbody>
</table>

The strength of the liquor potassae may be ascertained by taking its gr. The following extract from Mr. Dalton’s table (New System of Philos. part ii. p. 476) illustrates this:

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Atoms.} & \text{Potash per cent, by weight.} & \text{Spec. Gravity.} & \text{Boiling Point.} \\
\hline
\text{Potash} & \text{Water} & 39·6 & 1·47 & 265 deg. \\
1 & 8 & 34·4 & 1·42 & 246 \\
1 & 9 & 33·3 & 1·33 & 229 \\
1 & 10 & 19·5 & 1·23 & 220 \\
1 & 11 & 13 & 1·15 & 215 \\
1 & 12 & 9·5 & 1·11 & 214 \\
1 & 13 & 4·7 & 1·06 & 213 \\
\hline
\end{array}
\]

ence it appears that the liquor potassae of the London Pharmacopœia, whose sp. gr. is 1·063, consists of—

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>4·7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td>95·3</td>
</tr>
<tr>
<td>Liquor Potassae (Ph. L.)</td>
<td>100·0</td>
<td></td>
</tr>
</tbody>
</table>

**Physiological Effects. (a.) On vegetables.—** Caustic potash promptly destroys the parts of living plants with which it is placed in contact, and in the dilute state kills haricots (Phaseolus vulgaris) in a few hours. (Insect, in Decandolle, Phys. Végét.)

(b) **On animals generally.**—It acts on animals generally as an energetic caustic poison. It is, says Orfila (Toxicol. Génér.), of all poisons that eight most frequently perforates the stomach. He found that injected into the jugular vein of a dog it coagulated the blood, and caused speedy death. It is, however, remarkable that when mixed with the blood of the body, it not only does not coagulate it, but actually prevents spontaneous coagulation. Magendie has observed that by the exhibition of alkali to dogs, the urine acquires alkaline properties.

(c) **On man.**—The local action of caustic potash is exceedingly energetic. This is especially the case with solid potash. The alkali, of course, neutralizes any free acid in the part to which it is applied, and imposes whatever ammoniacal salts may be present, causing the evolution of ammoniacal gas. Its chemical action on the organized tissues is most powerful, as may be well illustrated by experiments. Thus, a little potash solution be rubbed between the fingers, the epidermis pieces corroded and dissolved, and a soapy feel is thereby produced. A piece of fibrin (muscle, for example) be digested in a solution of potash, an unpleasant ammoniacal odour is evolved, a little alkaline...
sulphuric is formed, and the fibrin is dissolved: the compound of fibrin and potash thus formed may be termed fibrate of potash. The addition of an acid precipitates the fibrin somewhat altered in its properties, and combined with some of the precipitant. The same kind of effect is produced by the action of potash on albumen: thus, this substance unites with the alkalies to form soluble compounds, which may be termed albuminates. Gelatine is also readily dissolved by alkalies, with the deposition of any phosphate of lime which it may contain. These phenomena are to a certain extent comparable to those of saponification. It appears, therefore, that the caustic alkalies form soluble compounds with substances which enter largely into the composition of the organic tissues. Hence the observation of Orfila, that alkalies are of all corrosive poisons those which most frequently perforate the stomach, is readily accounted for; for the intestinal mucus readily dissolves in alkalies whereas it is coagulated by acids; so that the former are much more quickly brought in contact with the living tissues. These resist, for a certain time, the chemical influence of the caustics, but the affinity being powerful, the vital properties soon cease to offer opposition—the part dies, and then the alkalies commence their chemical action on the tissues, which they speedily dissolve. Hence, if a large quantity of potash be swallowed, the most violent symptoms are observed, though they are of the same general kind as when the mineral acids have been taken.

When liquor potassæ is taken in small doses, and properly diluted, saturates the free acids contained in the stomach, and which the recent investigations of physiologists have shown to be so essential to the digestive functions. Hence the continued use of alkalies must be always injurious, since they disorder the assimilative process by altering the chemical properties of the healthy ventricular secretion.

If the quantity of potash swallowed be more than sufficient to neutralize the free hydrochloric acid, but insufficient to have any chemical action on the living tissues, it acts as a slight irritant, increases the secretions of the alimentary canal, becomes absorbed, and alters the quality of the secreted fluids, more particularly those of the urine. Moreover the modification thus produced in the quality of the renal secretion accompanied by an increase in the quantity, so that the alkalies are among our most powerful diuretics—an effect which may be in part owing to the local stimulus which they communicate to the secretory vessels in their passage through them.

By continued use the alkalies give rise to increased activity of different secreting organs, and of the absorbing vessels and gland effects which are analogous to those caused by mercury. After some time the digestive function becomes disordered, the appetite fails, the belly becomes thinner and darker coloured, and loses its power of spontaneous coagulation when drawn from the body; the whole system, and more particularly the digestive organs, become enfeebled; and a state precisely similar to that of scurvy is brought on. It is said if the alkalies temporarily suspended the blood speedily re-acquires its coagulability but loses it again when we resume their employment. These phenomena deserve especial notice, as being precisely analogous to those of scurvy, a disease which has been usually supposed to be brought on by the
Uses.—Caustic potash is employed for various purposes in medicine, the principal of which are the following:—

(a.) As an escharotic.—Potassa fusa is sometimes used as a caustic, though its employment is not free from objection; for its great deliquescence occasions some difficulty in localizing its action. It may be employed for the production of an issue, but we must proceed thus:—

Upon the part one or two layers of adhesive plaster, in the middle of which is an aperture of the exact size of the intended issue. Then moisten the potassa fusa, or the potassa cum calce, and rub on the part until discoloration is observed. Wash, and apply a linseed-meal poultice; and when the eschar is detached, insert the pea. In bites by venomous animals—as venemous serpents, mad dogs, &c.,—this escharotic may be used with advantage. Mr. Whateley recommends the potassa fusa as the agent for arming caustic bougies to be applied in strictures of the urethra; but the practice appears so dangerous (particularly on account of the deliquescence and violent action of the caustic), that I believe it is now rarely, if ever, resorted to. There are many other cases in which this substance is employed as a caustic; for example, to destroy ulcers and fungoid growths of various kinds, and to open abscesses, more especially those in the groin; but for the latter purpose the lancet is preferred.

(b.) As an antacid we resort to the liquor potassae in various affections of the digestive organs, which are attended with an inordinate secretion of acid, known by the acid eructations, cardialgia, and other dyspeptic symptoms. It must, however, be evident, that the neutralization of the acid is merely palliative. But the continued employment of alkalies frequently diminishes, temporarily, the tendency to acid secretion. Commonly it is found that the cases calling for the employment of alkalies are those benefited by tonics, and hence I believe the alkali is, in most cases, best given in some mild or tonic infusion; such, for example, the infusion of calumba, or of gentian, or of quassia; the sulphate of alumina oftentimes disagreeing with the stomach in these cases; besides which, it would be decomposed by the alkali. The beneficial effects of alkalies are said to be particularly observed in those forms of dyspepsia which result from the inordinate use of spirituous liquors. Of course the liquor potassae would equally neutralize acid which may be accidentally or purposely swallowed; but it is rarely given for this purpose, on account of its irritant qualities, and because many other agents (as chalk, whiting, magnesia, and soap) are equally efficacious as antacida, while they are free from the objections which exist in these cases to the use of the caustic alkalies.

(c.) To modify the quality of the urine, liquor potassae is a most suitable agent. I have already stated that, under the employment of alkalies, not only may the natural acidity of the urine be destroyed, but an alkaline property communicated to it; so that, whenever the creation of lithic acid, or of the lithates, is inordinate, the alkalies present themselves to our notice as chemical agents for counteracting
this condition. It has been supposed by some that the efficacy of the caustic alkalies in preventing the deposition of lithic acid grave consists in their holding it in solution—an explanation apparent inconsistent with the fact that the carbonated alkalies and magnesia are equally efficacious, though they are incapable of dissolving it. We are, therefore, led to the conclusion, that the alkalies, by the chemical influence, actually prevent the formation of this acid, or neutralize the free acid in the urine, which is the immediate cause of the precipitation of the lithic acid; whether by an action on the digestive organs or otherwise we know not. In resorting to these agents in urinary deposits, we should be careful to avoid employing them when there is any tendency to the deposition of the phosphates. The phosphate of lime, which naturally exists in the urine, is held in solution in this liquid by some acid, as seems proved by the fact, that the addition of a caustic alkali precipitates it. Berzelius thinks that the acid is the lactic; M. Brett (Medical Gazette, vol. xvii. p. 847), that it is the carbonic acid. The nature of the acid is, however, of secondary importance. It is generally admitted that the solvent is an acid, and that by the use of alkalies it may be obviated or neutralized, and the urine rendered alkaline. No what will be the necessary consequence of this? Evidently the deposition of phosphate of lime; so that the use of alkalies may actually cause the appearance of white sand in the urine; and in patients predisposed to its formation, its quantity may be increased. These facts, then, have an important bearing on practice. "I have known," says Mr. Brand (Quart. Journ. of Science, vol. ii. p. 198), "soda-water exhibited in case of stone in the bladder, produce abundance of white sand, which the ignorance of the patient and his medical attendant led them to refer the solvent power of the medicine upon the stone, which they thought was gradually giving way and being voided; whereas great mischief was doing, by giving the urine more than its usual tendency to deposit the phosphates, and, consequently, to augment the size of the calculus. In the treatment of the lithic acid diathesis, it is to be remembered that the use of alkalies is, to a certain extent, a palliative mode of treatment and that, to be successful, it should be conjoined with other means of cure.

(d.) The alkalies have been lately celebrated for producing beneficial effects in those inflammations which have a disposition to terminate in exudation and adhesion; that is to say, those that frequently give rise the formation of false membranes or of adhesions; such, for example, as croup, pleurisy, and peritonitis. If experience should subsequently confirm the assertions already made respecting their efficacy, we shall have another analogy between the operation of alkalies and of mercury. Theoretically, it has been argued, the alkalies are likely to be beneficial in these diseases on two accounts; first, they have a tendency to diminish the supposed plasticity of the blood, which some have assumed (though without proof) to be connected with the exudation; and, secondly, we find these albuminous deposits readily dissolve, out of the body, in alkaline liquids: but arguments of this kind are to be received with great caution. In conclusion, I may add that Eggert recommends the alkalies as specifics against croup, though Sundelin (Heilmittel. 1st. Bd. S. 18) found them inoperative. Hellwag employed them to cause the removal of the deposited lymph; Memminger gave them with benefit in hooping cough; Mascagni in pleurisy and peripneumony (Vogt, Lehrbuch
It is asserted that in the latter complaints the alkalis render the expectorated matter less viscid, and at the same time act powerfully as diaphoretics and diuretics.

(e) In induration and enlargement of the lymphatic and secreting glands the alkalis have also been recommended: for example, in bronchocele, mammary tumors, affections of the testicle, diseases of the mesenteric glands, induration of the liver and salivary glands, &c. I have seen the liquor potassae remarkably beneficial in excessive enlargement of the lenticular or glandular papillae at the base of the tongue.

(f) In syphilis and scrofula also the alkalis have been employed with advantage. Some of the most obstinate and troublesome forms of the venereal disease frequently occur in scrofulous subjects, in whom mercury will not only be useless, but absolutely prejudicial. In two or three cases of this kind I have seen the liquor potassae, taken in the compound decoction of sarsaparilla, of great benefit. Though scrofula may be relieved by the use of alkalis, there is no ground for believing that they have any power of curing this malady, as some have asserted.

(g) The alkalis have been employed as diuretics in dropsy, especially when this disease arises from glandular enlargements, or other causes likely to be relieved by these remedies.

(h) In irritable conditions of the urinary organs a combination of liquor potassae and tincture of opium will be frequently found most beneficial, notwithstanding that alkalis are classed among the incompatibles of opium.

There are several other diseases in which the employment of alkalis has been recommended; such as skin diseases, which are scaly (as lepra and psoriasis); chronic rheumatism; in uterine complaints, as an emmenagogue; and in some chronic diseases of the lungs. Sometimes a very dilute solution of potash has been used as a stimulating wash to ulcers.

Administration.—The mode of employing the potassa fusa in the making of an issue I have already described. For internal exhibition, the liquor potassae is used in doses of ten drops gradually increased to the extent even of a drachm, carefully watching its effects. It may be administered in the infusion of orange-peel. Table beer is said, by Dr. Paris, to disguise completely the nauseous flavour of the alkali; but, of course, if the beer be at all sour, the acid will neutralize the alkali, and destroy its antacid properties. Veal broth is another liquid for its administration; and we are told that Dr. Chittick's nostrum for the stone was the fixed alkali in this liquid.

Antidotes.—In poisoning by the alkalis, the antidotes are either acids or oil, both of which form salts with the alkalis, and diminish their causticity. Chereau prefers oil, which should be given to the extent of several pounds. Vinegar, lemon or orange juice, even the very diluted mineral acids, should be resorted to, if oil be not at hand.

Potassii Iodidum.—Iodide of Potassium.

History.—This salt, called also ioduret of potassium, and more commonly hydriodate of potash, was first employed in medicine by Dr. Coindet.

Natural History.—Iodine and potassium are contained in sea-water, as well as in sea-weeds, but whether the iodine is in combination with
potassium or with some other metal (sodium or magnesium) it is impossible to say with certainty.

**Preparation.**—There are two principal methods of procuring this salt.

(a.) Process of the Pharmacopoeia. — This consists in adding two ounces of iron filings to six ounces of iodine mixed with four pints of water, stirring them frequently with a spatula for half an hour. Apply a gentle heat, and, when a greenish colour appears, add four ounces of carbonate of potash, first dissolved in two pints of water, and strain. Wash the residue with two pints of boiling distilled water, and again strain. Let the mixed liquor be evaporated, that crystals may be formed.

The theory of this process is as follows:—One equivalent or 126 parts of iodide of iron combine with one equivalent or 28 parts of iron. The resulting iodide of iron is decomposed by one equivalent or 70 parts of carbonate of potash, by which one equivalent or 166 parts of iodide of potassium, and one equivalent or 58 parts of protocarbonate of iron are procured.

**Reagents.**

<table>
<thead>
<tr>
<th>Product</th>
<th>1 eq. Iodide</th>
<th>1 eq. Iodide Potassium</th>
<th>1 eq. Oxygen</th>
<th>1 eq. Pure Iodide Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>154</td>
<td>1 eq. Iron</td>
<td>8</td>
<td>1 eq. Potassium</td>
</tr>
<tr>
<td>Potash</td>
<td>70</td>
<td>1 eq. Carbonic Acid</td>
<td></td>
<td>1 eq. Carbit.</td>
</tr>
</tbody>
</table>

(b.) Dr. Turner's process.—This is the simplest, and I believe the most eligible method. It consists in adding to a hot solution of pure potash as much iodine as the liquid will dissolve, by which means a reddish-brown fluid is obtained. Then pass hydrosulphuric acid through the liquid until it becomes colourless. Apply a gentle heat, to expel any excess of the acid; filter to get rid of the free sulphur, and exactly neutralize the free acid present, with potash; then crystallize. When the potash comes in contact with iodine two salts are formed, iodide of potassium and iodate of potash; the latter is decomposed by the hydrosulphuric acid, the hydrogen of which forms water, by combining with the oxygen of the iodate; sulphur is precipitated, and iodide of potassium remains in solution. This process has been subsequently modified thus: Iodate of potash is decomposed by exposing it to a red heat in a platinum crucible, instead of hydrosulphuric acid.

**Properties.**—This salt occurs in white, somewhat shining, transparent, or semi-opaque cubes, or octahedrons. Its taste is acrid saline, somewhat similar to common salt: it is without odour. It is readily fusible, and at a red heat volatilizes unchanged. It decrепitates when heated, in consequence of the water which is mechanically lodged between the plates of the crystal. Both water and alcohol readily dissolve it: it requires only two-thirds of its weight of water to dissolve it at 60° F. Iodine is readily dissolved by an aqueous solution of this salt.

**Characteristics.**—This salt is known to be an iodide by the following characters:—(a.) With a solution of bichloride of mercury it occasions a vermilion-red precipitate of the biniodide of mercury, which is very soluble in excess of iodide of potassium. (b.) With acetate of lead it forms a yellow precipitate of the iodide of lead. (c.) With the nitrate of silver, a yellow precipitate of the iodide of silver. (d.) With the protonitrate of mercury or with calomel a greenish yellow precipitate of the
iodide of mercury. (e) On the addition of starch and a few drops either sulphuric or nitric acid, or of a solution of chlorine, (according Devergie, a mixture of chlorine and nitric acid succeeds best) the iodide of starch is formed. (f) Chloride of platinum produces a whiteish red solution of iodide of platinum.

That the base of this salt is potassium is shewn by the following characters:— (a) perchloric acid occasions a white precipitate of perchlorate of potash, while the supernatant liquid becomes yellowish brown.

An excess of a strong solution of tartaric acid produces a white precipitate of the bitartrate of potash. (c) Carbazotic acid forms yellow needle-like crystals of carbazotate of potash. (d) If a pack-thread be dipped in a solution of the iodide, and the wetted end dipped into melted lead, and applied to the exterior cone of the flame of a candle, this he assumes a pale or whitish violet colour.

COMPOSITION.—This salt consists, as its name indicates, of iodine and potash.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine</td>
<td>1</td>
<td>126</td>
<td>76</td>
</tr>
<tr>
<td>Potassium</td>
<td>1</td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td>Iodide Potassium</td>
<td>1</td>
<td>166</td>
<td>100</td>
</tr>
</tbody>
</table>

The crystals contain no water of crystallization.

ADULTERATION.—Iodide of potassium is frequently largely adulterated with carbonate of potash. In 1829 I analyzed a sample which contained per cent. of the latter salt (Med. and Phys. Jour. September, 1829.) In a specimen Dr. Christison procured 74.5 per cent. of carbonate of potash, 16 of water, and only 9.5 of iodide of potassium (Treatise on Poisons, 3d edit. p. 182.) It is reported that this adulterated salt is manufactured in the neighbourhood of Glasgow. The impure salt may be distinguished, by its wanting any regular crystalline form; by adding a few particles of it to lime-water a milky fluid is obtained, whereas the liquid remains transparent if the iodide be pure; by its destroying the tincture of iodine, whereas the pure salt does not affect it; and by alcohol, which dissolves iodide of potassium, but not carbonate of potash.

Traces of the chlorides and sulphates are not unfrequent in commercial iodide of potassium. To detect the chlorides add nitrate of silver, which precipitates the carbonates, chlorides, and iodides, and digest the precipitate in ammonia, which re-dissolves the chloride, but not the iodide of silver. On the addition of nitric acid to the ammoniacal solution, the chloride is thrown down, while the carbonate is converted into nitrate of silver. The sulphates may be detected by chlorid of barium, which will occasion a white precipitate (sulphate of baryta) insoluble in nitric acid.

I have met with a variety of iodide of potassium, which, by keeping, undergoes decomposition, evolves an odour of iodine, and becomes yellow. I have also samples of iodide of potassium (crystallized in octahedrons), containing traces of lead and tin, derived I presume from the vessels in which the salt has been made or crystallized.

PHYSIOLOGICAL EFFECTS. (a) On plants.—The effects of this salt on getables have not been ascertained.

(b) On animals generally.—The experiments of Devergie on dogs (performed in his Médicine Légale, t. ii. p. 536), as well as those of Dr.
Cogswell on rabbits (Experim. Essay on Iodine, 1837), have shown that to these animals, iodide of potassium is a powerful poison. It operates as a local irritant, and thereby inflames the tissues with which it is placed in contact. Four grains injected into the jugular vein of a dog caused convulsions, and death within a minute. Two drachms introduced in the stomach gave rise to vomiting and great depression: the latter increased until death, which occurred on the third day: after death ecchymosis, ulceration, and redness of the stomach, were observed (Devergie, op. cit. p. 506.) Dr. Cogswell injected three drachms of iodide beneath the skin of the back of a dog: the animal died on the third day: on chemical examination iodine was detected in the blood from the heart, in the brain and spinal cord, the liver, spleen, stomach muscles, tongue, and the bones freed from their appendages; likewise in the contents of the bladder. (Cogswell, op. cit. p. 91.)

(c.) On man.—Both the physiological effects and therapeutical uses of iodide of potassium shew that the operation of this salt is analogous that of iodine.

The local action of iodide of potassium is that of an irritant. When taken internally in large doses it not unfrequently occasions nausea, vomiting, pain and heat of stomach, and purging. Applied to the skin in the form of ointment it sometimes produces slight redness. This action is much less energetic in its action than free iodine, and, therefore, may be given in larger doses and continued for a longer period, without evincing the same tendency to produce disorder of the stomach and intestines.

Lugol (Essays, translated by Dr. O'Shaughnessy, p. 65) found that baths at 100° F. containing three ounces of iodide of potassium produced temporary itching only; whereas baths at the same temperature containing ten scruples of iodine caused prickling, then itchiness, swelling, rubefaction (which was not commensurate with the itchiness), punctuated, separated, or confluent, and subsequently desquamation of the epidermis. The chemical action of iodide of potassium on the tissues is slight, as indeed might be expected, seeing that no obvious changes are produced when a solution of this salt is mixed with albumen, fibrin, gelatine, the three most abundant organic constituents of the animal body.

Iodide of potassium becomes absorbed and is carried out of the system by the different secretions, in which, as well as in the blood, it may be easily detected (Buchanan, Med. Gaz. vol. xviii. p. 519; Wallace, Lancet for 1835-36, vol. ii. p. 6: the latter authority failed to detect it in the blood). Moreover, it deserves especial notice that it has been found in the urine several days after it has been swallowed. (Christison, Treat on Poisons, 3rd ed. p. 185.)

The remote or constitutional effects of iodide of potassium are analogous to those of iodine. Diuresis is a common consequence of use. Relaxation of bowels is not unfrequent. Occasionally ptyalism has been observed. (Dr. Clendinling, Med. Gaz. vol. xv. p. 569, and 1. Wallace, Lancet, for 1835 and 36, vol. ii. p. 8.) Dr. Wallace mentions irritation of throat as being produced by this salt. Atrophy of the mammae is a very rare effect of it, but a case is mentioned by Mr. New Hill, (Edinb. Med. and Surg. Journ. vol. xxv. 1826, p. 282.) Headache, watchfulness, and other symptoms indicative of the action of this salt on the nervous system, have been noticed by Dr. Clendinling and Dr. Wallace.
increased secretion from, and pain of, the mucous membrane lining the
nasal passages, have been observed. I have repeatedly remarked that the
o'clock-handkerchiefs used by patients who are taking this salt acquire
distinct odour of iodine.

Great discrepancy exists in the statements of authors as to the effects
of given doses of iodide of potassium. "The average dose of this me-
cicine," says Dr. Williams (Med. Gaz. vol. xiv. p. 42) "is eight grains;
arrived beyond that quantity it purges; and even limited to that quantity,
requires some management to obviate nausea." In two cases mentioned
by Dr. Wallace (Lancet, for 1835-6, vol. ii. p. 9) a drachm of this salt
when in divided doses caused vomiting, colicky pains, slight diarrhoea,
equency of pulse, and exhaustion. These statements, then, shew that
this salt possesses very active properties, and coincide with the expe-
rience of many practitioners, and with the results obtained from exper-
iments on animals. But we have, in opposition to the above, the
reference of Dr. Elliotson (Lancet, vol. i. 1831-2, p. 728) and of Dr.
uchanan (Med. Gaz. vol. xviii. p. 519). The first tells us that six
drachms may be given daily (in doses of two drachms) for many weeks
without inconvenience; and the second states half an ounce may be
iven at a dose without producing pain of the stomach or bowels,
urging, or any hurtful effect. Furthermore, both physicians vouch for
the purity of the salt employed. It is difficult to explain such discrepant
statements. But I cannot help thinking that peculiarities of constitution
and morbid conditions of system (especially affections of the stomach)
were principally concerned in modifying (either increasing or diminishing)
tolerance to this salt. I do not think that the different effects
observed can be wholly ascribed to alterations in the quality or
alterations of the medicine employed, though I have published a case
Med. Gaz. vol. xvii. p. 839), shewing that the adulterated is much less
active than the pure salt.

Uses.—Having so fully detailed (p. 117 et seq.) the uses of iodine, it
is unnecessary to notice at any length those of iodide of potassium, since
they are for the most part identical. Thus it has been employed in
onchocele, scrofula, in chronic diseases accompanied with induration
and enlargement of various organs, in leucorrhœa, secondary syphilis,
articular rheumatism, dropsies, &c. As a remedy for the
3rd periosteal node brought on by syphilis, it was first employed by
Dr. Williams (Med. Gaz. vol. xiv. p. 42) who obtained with it uniform
success. At the end of from five to ten days its mitigating effects are
felt; the pains are relieved, the node begins to subside, and in the
majority of cases disappears altogether. In these cases Dr. Clendin
ing Med. Gaz. vol. xv. p. 833) has also borne testimony to its efficacy.
In the tubercular forms of venereal eruptions, Dr. Williams found it
unofficial. In Dr. Wallace’s lectures (Lancet, for 1835-36, vol. ii. and for
1836 and 1837, vols. i. and ii.) are some valuable observations on the use
of iodide of potassium in venereal diseases. In chronic rheumatism
accompanied with alteration in the condition of the textures of the joint,
is, in some cases, remarkably successful (Dr. Clendinming, Med. Gaz.
vol. xv. p. 866; and Dr. Macleod, Med. Gaz. vol. xxi. p. 361). As an
ingredient for baths, Lugol (Essays, p. 75) found the iodide would not
swear alone, but that it was useful as a solvent means for iodine.

Administration.—Iodide of potassium may be employed alone or in
conjunction with iodine, forming what is called ioduretted iodide of potassium.

1. Of Iodide of Potassium.—Internally it has been given in doses varying from three grains to half an ounce (see p. 283). To be beneficial, some think it should be given in small, others in larger doses. Not having had any experience of the effects of the enormous doses before referred to, I can offer no opinion thereon. It may be administered dissolved in simple or medicated water, or in some bitter infusion. The more usual mode of exhibiting it is in combination with iodine, in the way presently to be noticed.

For external application iodide of potassium is used in the form of ointment. The unguentum potassae hydriodatis of the Dublin Pharmacopoeia consists of a scruple of iodide to an ounce of lard; but for ordinary purposes it should contain at least a drachm of iodide. By keeping it undergoes decomposition and acquires a yellow colour, a little iodine being set free. It has an advantage over the compound iodine ointment of the London Pharmacopoeia, that it does not stain the skin.

2. Of Ioduretted Iodide of Potassium.—A solution of iodide of potassium readily dissolves free iodine, and the compound is usually termed ioduretted iodide of potassium. Iodine and iodide of potassium are also used together in the form of ointment.

For internal administration there are three preparations of ioduretted iodide of potassium which have been employed: the ioduretted mineral water of Lugol; the compound solution of iodide of potassium of the London Pharmacopoeia; and the compound tincture of iodine of the same work.

(a.) Ioduretted mineral water.—This is Lugol’s favourite preparation. He uses it of three different degrees of strength.

<table>
<thead>
<tr>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine . . . . . . . . .</td>
<td>gr. 2</td>
<td>i</td>
</tr>
<tr>
<td>Iodide of Potassium . . . . . . . . .</td>
<td>gr. 1/2</td>
<td>ii</td>
</tr>
<tr>
<td>Distilled Water . . . . . . . . . .</td>
<td>3/8 viii</td>
<td>3/8 viii</td>
</tr>
</tbody>
</table>

The solutions are yellowish or orange coloured, and are quite transparent. When sweetened it is readily taken by children, but the sugar should be added at the time of administration, as in the course of a few hours it effects a chemical change in the solution. From six to eight ounces should be taken daily.

(b.) Compound solution of iodide of potassium.—The liquor potassae iodidi compositus of the London Pharmacopoeia consists of:

| Iodine . . . . | gr. v |
| Iodide of Potassium . . . . . | gr. x |
| Distilled Water . . . . . . . . | 3/2 xx |

It is a brown coloured solution, and may be usefully employed in the diseases of children. Dose for adults from two to six or more fluidrachms.

(c.) Compound tincture of iodine.—The tinctura iodinii composita of the London Pharmacopoeia consists of:

| Iodine . . . . . . . . . . . . . . . | 3 ii |
| Iodide of Potassium . . . . . . . . . . . | 3 ii |
| Rectified Spirit . . . . . . . . . . . . . | 0 ii |
IODIDE OF POTASSIUM.

This solution may be mixed with water without any deposition of line. The dose of it at the commencement is ten minims, which may be gradually increased.

For external application ioduretted iodide of potassium is used in the form of aqueous solution, or of ointment.

(a.) *Caustic, rubefacient, and stimulant solutions.*—These are employed by Lugol of the following strengths:

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Iodine . . . . . . 2 gr. ii.</td>
<td>⅔ i.</td>
<td>⅓ ii.</td>
</tr>
<tr>
<td>2</td>
<td>Hydriodate Potash 4 gr. vi.</td>
<td>⅓ iv.</td>
<td>⅓ i.</td>
</tr>
<tr>
<td>3</td>
<td>Distilled Water . Ⅹvi.</td>
<td>⅔ vi.</td>
<td>⅔ i.</td>
</tr>
</tbody>
</table>

Lugol uses the stimulating washes in scrofulous ulcers, ophthalmia, tuberculous abscesses, &c. When the scrofulous surfaces require stronger excitation than usual, he employs the rubefacient solution. In tubercular tumors which have obstinately resisted all other means of treatment, the rubefacient solution may be applied in admixture with linseed meal forming the *ioduretted cataplasm* of Lugol. To prepare the mixture, the poultice is first made in the ordinary manner; and when moderately hot, a sufficient quantity of the rubefacient liquid poured on it with a wooden measure. The caustic solution is used for touching the eyelids and nasal fossæ, to repress excessive granulations, &c.

(b.) *Ioduretted baths.*—These are employed by Lugol in the treatment of scrofula. They are to be made in wooden vessels.

### IODURETTED BATHS FOR CHILDREN.

<table>
<thead>
<tr>
<th>Age</th>
<th>Water</th>
<th>Iodine</th>
<th>Iodide of Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Quarts.)</td>
<td>(Troy Grains.)</td>
<td>(Troy Grains.)</td>
</tr>
<tr>
<td>4 to 7</td>
<td>36</td>
<td>30 to 36</td>
<td>60 to 72</td>
</tr>
<tr>
<td>7 . . . 11</td>
<td>75</td>
<td>48 . . 60 . . 72</td>
<td>96 . . 120 . . 144</td>
</tr>
<tr>
<td>11 . . . 14</td>
<td>125</td>
<td>72 . . 96</td>
<td>144 . . 192</td>
</tr>
</tbody>
</table>

### IODURETTED BATHS FOR ADULTS.

<table>
<thead>
<tr>
<th>Degree</th>
<th>Water</th>
<th>Iodine</th>
<th>Iodide of Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Quarts.)</td>
<td>(Drachms Troy.)</td>
<td>(Drachms Troy.)</td>
</tr>
<tr>
<td>No. 1.</td>
<td>200</td>
<td>2 to 2½</td>
<td>4 to 5</td>
</tr>
<tr>
<td>No. 2.</td>
<td>240</td>
<td>2 . . 2½ . . 3</td>
<td>4 . . 5 . . 6</td>
</tr>
<tr>
<td>No. 3.</td>
<td>300</td>
<td>3 . . 3½</td>
<td>6 . . 7</td>
</tr>
</tbody>
</table>

(c.) *Ioduretted ointment.*—The *unguentum iodinii compositum*, Ph. L., is made by rubbing half a drachm of iodine with a drachm of iodide of potassium and a fluiddrachm of rectified spirit: then mix with two ounces of lard.

**Antidotes.**—No chemical antidote is known. In a case of poisoning, therefore, the first object will be to evacuate the contents of the stomach, exhibit demulcent and emollient drinks, combat the inflammation by the usual antiphlogistic measures, and appease the pain by opiates.
Potassii Bromidum.—Bromide of Potassium.

History.—This salt, also called hydrobromate of potash, was first described by Balard in 1826 (Ann. de Chim. xxxii.)

Natural History.—(See Iodide of Potassium.)

Preparation.—The modes of preparing bromide of potassium are analogous to those of the iodide.

In the Pharmacopoeia the bromide is directed to be made by adding first an ounce of iron filings and afterwards two ounces of bromine to a pint and a half of distilled water. Set them by for half an hour, frequently stirring with a spatula. Apply a gentle heat, and when a greenish colour is produced, pour in the carbonate of potash dissolved in a pint and a half of water. Strain and wash what remains in two pints of boiling distilled water, and again strain. Let the mixed liquors be evaporated so that crystals may be formed.

In this process bromide of iron is first formed, and afterwards decomposed by carbonate of potash, by which protocarbonate of iron and bromide of potassium are produced.

Reagents. Results.

1 eq. Brom\textsuperscript{e}.Iron\textsubscript{06} 1 eq. Bromine 78 1 eq. Brom\textsuperscript{e}.Potass\textsuperscript{a}. 118

1 eq. Bromine 78 1 eq. Brom\textsuperscript{e}.Potass\textsuperscript{a}. 118

1 eq. Bromine 78 1 eq. Brom\textsuperscript{e}.Potass\textsuperscript{a}. 118

1 eq. Iron .28 1 eq. Potass\textsuperscript{a}. 40

1 eq. Oxygen 8 1 eq. Protox.Iron \textsuperscript{36} 36

1 eq. Carb.A\textsuperscript{c}. 22 1 eq. Carbonate Iron .58

Another mode of procuring this salt is to mix bromine with a solution of caustic potash, by which bromide of potassium and bromate of potash are formed (see diagram, p. 123). The bromate of potash may be converted into bromide of potassium by heat or hydrosulphuric acid.

Properties.—This salt crystallizes in whitish transparent cubes, or rectangular prisms. It is inodorous: its taste is pungent, saline, and similar to common salt, but more acrid. It is permanent in the air. When heated it decrепitates, and at a red heat fuses without suffering decomposition. It is very soluble in both cold and hot water, and slightly so in alcohol.

Characteristics.—That this salt is a bromide is known by the characters before mentioned (see the characteristics of the bromides, at p. 124) That its base is potassium is shown by the characters of this metal mentioned when noticing iodide of potassium (see p. 281.)

Composition.—This salt consists of bromine and potassium in the following proportions:

<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromine</td>
<td>1</td>
<td>78</td>
<td>66'1</td>
<td>65'56</td>
<td>67'42</td>
</tr>
<tr>
<td>Potassium</td>
<td>1</td>
<td>40</td>
<td>33'9</td>
<td>34'44</td>
<td>32'58</td>
</tr>
</tbody>
</table>

Bromide Potassium . 1 . . 118 . . . 100'0 . . 100'00 . . 100'00

The crystals contain water lodged mechanically between their plates, but no combined water (water of crystallization).

Purity.—The purity and goodness of this salt may be known by the following characters:—The form of the crystals, their freedom from colour.
their neutrality with respect to litmus and turmeric. A solution of
salt should give no precipitate with chloride of barium, showing the
ence of carbonates and sulphates. The method employed by Rose
urn. de Pharm. t. 23, p. 489) for detecting minute quantities of the
orides in bromides, is the following:—If pure bromide of potassium
ed with excess of bichromate of potash be distilled with concentrated
uric acid in a tubulated retort, to which is adapted a receiver con-
ing excess of solution of caustic ammonia, pure brome distils over, and
ammoniacal liquor remains perfectly colourless. But if the bromide
ained a chloride, both brome and the chromate of chloride of
onium distil over, and the ammoniacal liquor becomes yellow: omic acid may be detected in the solution by the usual tests.
physiological Effects.—(a) On vegetables.—The effects on plants
not been ascertained.

b.) On animals.—Thirteen grains of bromide of potassium dissolved in
er, and injected into the jugular vein of a dog, coagulated the blood,
ed convulsions and death in a few minutes (Barthez, Journ. de Chim.
. t. 5me. p. 214). The same experimenter introduced a drachm of
salt into the stomach of a dog without any ill effects, save vomiting.
two drachms, and even a drachm and a half, killed dogs in three
es, when retained in the stomach by a ligature of the gullet, with
cks of inflammation in the gastro-intestinal membrane. Maillet (Journ.
 Chim. Méd. t. 3, 2e. Serie, p. 225) gave two ounces to a dog without
ill effect; and he observes, that according to the principle, that the
 of a saline substance for the horse should be eight-times that for the
, a pound of bromide of potassium would have no ill effect on
ses.

c.) On man.—The effects of bromide of potassium on man require
her investigation. They appear to be analogous to those of iodide of
assum. Dr. Williams (Elements of Medicine, vol. i. p. 338) gave five
ns of this salt three times daily for fourteen months, without any
arious effect.

In most cases it acts as a diuretic. In irritable conditions of the ali-
tary tube it is apt to occasion diarrhea. Three cases are mentioned by
Williams, in which, on account of this state of the bowels, more than
or five grains could not be exhibited at a time, and even then it was
onally necessary to give opium. Under the continued use of it,
argements of the spleen and liver, and swellings of the lymphatic
ds, have disappeared; so that it appears to agree with iodine, mer-
r, and the alkalies, in exercising that kind of influence over the nutri-
of the body which has been designated by the terms resolvent, 
ative, and deobstruct. Dr. Williams thinks that it possesses
ual, if not specific, powers in the cure of diseases of the spleen."
ises.—In 1828, Pourché (Journ. de Chim. Méd. tom. iv. p. 594) em-
ed this salt with benefit in the treatment of bronchocele and scrofula:
was taken internally, and applied externally in the form of ointment.
836 it was introduced into the London Pharmacopoeia, in conse-
ce of the great success obtained from the use of it in a case of
rged spleen, under the care of Dr. Williams (op. cit.) In this, and
three other successful cases of the same disease, it was used internally
. Dr. Williams also gave it with success in a case of ascites. Ma-
die (Formulaire, 8me. ed. 1835) employs it as an anti-scorfulous remedy,
as an emmenagogue, and against hypertrophy of the ventricles. Preg (quoted by Dierbach, *die neuesten Entdeck. in d. Mat. Med. 1837*) applied it externally in the form of ointment in tinea capitis.

**Administration.**—It is exhibited in the form of pill or solution doses of from four to ten grains three times a day. An ointment this salt is made by mixing an ounce of lard with from a scruple to two drachms of the bromide. To this some persons add free brome.

**Antidotes.**—In a case of poisoning by this salt the treatment will the same as for iodide of potassium.

**Potas'sii Sulphure'tum.—Sulphuret of Potas'sium.**

**History.**—Geber (*Invention of Verity, ch. vi.*) was acquainted with the solubility of sulphur in an alkaline solution; but Albertus Magnus taught the method of procuring sulphuret of potassium by fusion. The preparation kept in the shops is a mixture of the sulphuret of potassium and sulphate of potash, and was formerly called *sulphuret of potash, liver of sulphur.*

**Preparation.**—It is ordered to be prepared by rubbing one ounce sulphur with four ounces of carbonate of potash, and heating them in covered crucible until they have united.

In this process the water and carbonic acid of the carbonate of potash are expelled. The oxygen and potassium of a portion of the potash unite with separate portions of sulphur to form sulphuric acid and sulphuret of potassium respectively. The sulphuric acid combines with some undecomposed potash to form sulphate of potash. Suppose the carbonate of potash to be anhydrous, and the sulphuret of potash to consist of one equivalent of each of its constituents, the following diagram will explain the changes:

**Reagents.**

<table>
<thead>
<tr>
<th>4 eq. Carb.</th>
<th>1 eq. Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash .280</td>
<td>1 eq. Potash</td>
</tr>
</tbody>
</table>


Berzelius (*Traité de Chim. t. 2me. p. 301*) says that if 100 parts common anhydrous carbonate of potash be heated with 58-22 of sulphur the products are tersulphuret of potassium and sulphate of potash. If less than this quantity of sulphur be employed, a portion of carbon remains undecomposed.

**Properties.**—When fresh prepared, it has a liver-brown colour; hence its name hepur sulphuris. Its taste is acrid, bitter, and alkaline. If quite dry it is inodorous, but when moistened it acquires the odour of hydrosulphuric acid. Exposed to the air, it undergoes decomposition from the action of the aqueous vapour and oxygen. It becomes greasy and moist, and ultimately whitish. This change depends on the absorption of oxygen, in consequence of which part of the sulphur is deposited while a portion of the sulphuret of potassium is converted into hydrosulphite, afterwards into sulphite, and ultimately into sulphate of potash. Sulphuret of potassium is soluble in water.

**Characteristics.**—Hydrochloric acid causes the evolution of hyd.
SULPHURET OF POTASSIUM. 289

Sulphuric acid gas and the precipitation of sulphur; the solution of the sulphuret in water produces a reddish or black precipitate with a odour of lead. That it contains potassium may be determined thus:—

Add excess of hydrochloric acid to a solution of it; boil, and filter. he before-mentioned tests for potash may be then applied.

Composition.—According to Berzelius this preparation consists of sulphuret of potassium, sulphate of potash, and carbonate of potash.

Physiological Effects. (a.) On plants.—There can be no doubt that this compound is a powerful poison to plants, though I am not acquainted with any experiments made with it.

(b.) On animals generally.—From the experiments of Orfila (Toxicol. Intern. leprare) on dogs, sulphuret of potassium appears to be a powerful narcotic-acrid poison. Six drachms and a half, dissolved in water, and introduced into the stomach, caused convulsions and death in seven minutes.

(c.) On man.—In small doses (as from four to ten grains) it acts as a nerual stimulant, increasing the frequency of the pulse, augmenting the at of the body, promoting the different secretions, more especially those the mucous membranes, and sometimes exciting local irritation, marked pain, vomiting, and purging. By continued use it acts as a resolvent alterative, and on this account is employed in certain forms of inflam-

In large doses it is an energetic narcotico-acid poison. In two stances it proved fatal in fifteen minutes: the symptoms were, acridi-, slight vomiting, mortal faintness, and convulsions, with an impor-
tant chemical sign, the tainting of the air of the chamber with the odour hydrosulphuric acid (Chrisíson, p. 228).

Its local action is that of a powerful irritant: hence the acrid taste, rning pain, and constriction in the throat, gullet, and stomach, with niting and purging. But the nervous system also becomes affected, is proved by the faintness, the almost imperceptible pulse, the con-
sions, and (in some cases) sopor. These symptoms are analogous to se caused by the hydrosulphuric acid; which, in fact, is copiously eloped in the stomach.

Uses.—Internally it has been administered in very obstinate skin dis-
ases, such as lepra and psoriasis, which have resisted all the ordinary ans of cure. It has also been employed as a resolvent in inflamma-
tions attended with lymphatic exudation, as croup, and in glandular argements. In chronic rheumatism, gout, hooping-cough, and various er diseases, against which it was formerly employed, it is now rarely ever administered. It ought not to be given as an antidote for metallic soning, since it is itself a powerful poison.

Externally it is applied in the form of lotions, baths, or ointment. In tonic skin diseases, such as eczema, scabies, lepra, &c. it is employed a bath, in the proportion of four ounces to thirty gallons of water. ese baths are said to be particularly useful in the treatment of scabies children, but twenty at least are requisite to effect a cure. (Rayer, atise on Diseases of the Skin, p. 346.) Lotions are sometimes made local cutaneous affections, containing a larger quantity of the sulphuret an ounce to two quarts of water.

Administration.—Internally it may be administered in the dose of
three or four grains gradually increased. It may be given either in solution or in the form of pill made with soap. For external use it is employed in solution in water, as already described, or in the form of ointment, composed of half a drachm of the sulphuret to an ounce of laudanum.

**Antidotes.**—In the event of poisoning by this substance the antidote is a solution of chloride of soda or of chloride of lime.

*Potassa* see *Bisulphates.*—*Bisulphate of Potash.*

**History and Synonymes.**—The mode of preparing this salt was taught by Lowitz and Link at the latter end of the last century. The salt has had various names, such as *supersulphate of potash*, *sal enixum*, *acet vitriolatum tartar*; and *sal auri philosophicum*.

**Preparation.**—It is ordered to be prepared by dissolving two pounds of the salt left after the distillation of nitric acid in four pints of boiling water, then adding one pound of sulphuric acid to it, boiling down the mixture, and setting aside to crystallize. It is also a product of various other manufactures.

**Properties.**—It is crystallizable, the primary form of the crystal being either a right rhombic prism, or the right rhombic octahedron. It has a very acid taste, and reacts strongly as an acid on vegetable colours, and decomposes the carbonates with effervescence. It is soluble in about twice its weight of water at 60°. By a red heat it evolves sulphuric acid, and is converted into the neutral sulphate of potash.

**Composition.**—It consists of—

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</thead>
<tbody>
<tr>
<td>Sulphuric Acid</td>
<td>2</td>
<td>80</td>
<td>54.80</td>
<td>54.77</td>
</tr>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>32.87</td>
<td>32.53</td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>18</td>
<td>12.33</td>
<td>12.70</td>
</tr>
<tr>
<td>Crystallized Bisulphate Potash</td>
<td>1</td>
<td>146</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Characteristics.**—The presence of sulphuric acid may be recognized by the chloride of barium; while the potash may be detected by the characters already mentioned for this substance. From the neutral sulphate of potash it is distinguished by its acid taste, its action on litmus and the alkaline carbonates, and by its greater solubility.

**Physiological Effects and Uses.**—It is rarely used as a medicine. It possesses the combined properties of sulphuric acid and sulphate of potash. The excess of acid renders its local operation that of an astringent. When swallowed, it operates as a mild purgative, and may be employed in the same cases as the sulphate, over which it has the advantage of greater solubility. Conjoined with rhubarb it covers the bitter taste of the latter without injuring its medicinal properties. Dr. Bark (Observations on the Dublin Pharmacopeia, p. 138) says it may be used to form a cheap effervescing purgative salt, as follows:—73 grains of bisulphate of potash and 72 grains of crystallized carbonate of soda, to be separately dissolved in two ounces of water, and taken in a state of effervescence.

**Administration.**—The dose of it is from gr. x. to 5ij, properly diluted.
History and Synonymes.—The mode of preparing this salt was taught Oswald Croll in 1643. It has been known by various appellations, such as specificum purgans Paracelsi, Arcanum duplicatum, vitriolated i, vitriolated tartar, sal polychrest (literally signifying salt of many uses or virtues), sal de doobus, &c.

Natural History.—Sulphate of potash is found in both kingdoms of nature.

a.) In the inorganized kingdom.—It has been met with in small quantities in some mineral waters of Saxony and Bohemia, in native alum, alum-stone, and in a mineral called polyhalite, in which Stromeyer found no less than 27.6 per cent. of the sulphate of potash.

b.) In the organized kingdom.—It has been found in the root of Polytrichum Senega, Winter's bark, the bulb of garlic, myrrh, opium, &c. The seed and urine of man also contain it.

Preparation.—It is obtained from the residuum of the distillation of the acid, either by igniting it in a crucible to expel the excess of sulphuric acid, as directed in the Pharmacopoeia, or by saturating it with carbonate of potash.

Properties.—It crystallizes in single or double six-sided pyramids, the primary form of which is the right rhombic prism. It is hard, dourous, has a saline bitter taste, and is unchanged by exposure to the air.

When heated it decrepitates. At 60° F. it requires sixteen times its weight of water to dissolve it: it is insoluble in alcohol. It is decomposed by tartaric acid, which forms with it crystals of bitartrate of potash.

Composition.—The crystals contain no water of crystallization. They thus composed:

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</tr>
</thead>
<tbody>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>45.45</td>
<td>45.25</td>
</tr>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>54.55</td>
<td>54.75</td>
</tr>
</tbody>
</table>

Sulphate of Potash | 1 | 88 | 100.00 | 100.00 |

Characteristics.—I have already mentioned these, when describing bisulphate.

Physiological Effects.—It acts as a very mild purgative, without exciting any heat, pain, or other symptoms of irritation. Its operation, in fact, too mild for ordinary use.

Uses.—It is particularly serviceable as a laxative in disordered conditions of the alimentary canal, as diarrhoea and dyspepsia, in hepatic disorders, and in haemorrhoidal affections. It is best given in combination with rhubarb. Thus, from five to ten grains of rhubarb, with from ten grains to two drachms of this salt, will be found to act mildly and efficiently in many cases of dyspepsia and diarrhoea. It is an excellent remedy for children. The objections to its employment are its slight balm, and that when given in large doses to children it is apt to produce vomiting. It is useful, on account of its hardness, for triturating dividing powders, as in the pulpis ipecacuanhae compositus.

Dose.—It is given in doses of from fifteen grains to four or five drachms.
Potas'sae Nitrata.—Nitrate of Pot'ash.

History.—At what time this salt became known is difficult now to determine. As it is found in various parts of the East, on the surface of the earth, it appears probable that it must have been known at a very early period. Furthermore, if the Chinese and Hindoos were acquainted with the art of making gunpowder and fireworks at a very early period of history, they must have employed, and, therefore, been acquainted with nitre. Geber, (Invention of Verity) however, is the first who distinctly mentions it. But the terms neter of the Old Testament (Prov. ch. xxv. 27; Jer. ch. ii. 22), translated nitre,—virpov of Herodotus (Euterpe, Ixxxvi) and Theophrastus (De Igné)—and nitrum, of Pliny (Hist. Nat. xxx. i.) appear to have been applied either partially or exclusively to nitrum (sou-qui-carbonate of soda.) (See Beckman's History of Inventions and Discoveries, vol. iv.) The word saltpetre, usually applied to nitre, is evidently derived from sal petre, literally signifying rock salt.

Natural History.—This salt occurs in both kingdoms of nature.

(a) In the inorganised kingdom.—In the East Indies, Egypt, Persia, Spain, and other parts of the world, large quantities of nitre are found in the soil. It would appear to be formed below, and to be brought to the surface of the soil by efflorescence. Some have thought that the nitric acid of the salt was formed by the union of the nitrogen and oxygen in the atmosphere, while others have supposed the presence of animal matters necessary to yield, by their decomposition, nitrogen. In some instances the latter opinion is probably correct: but it does not invariably hold good, for in a nitre cave at Ceylon, Dr. Davy (Account of the Interior of Ceylon) found nitre without any animal matter. The potash nitrate is in most cases easily accounted for, being found in some of the constituents of the soil, namely, feldspar and mica.

(b) In the organized kingdom. This salt has been found in various plants, as in the roots of Cissampelos Parevra, Geum urbanum, &c. (L. Candolle, Phys. Végét. p. 387.)

Preparation.—The nitrate of potash consumed in this country is imported from India, where it is obtained from natural sources. In some parts of Europe it is procured artificially.

1. From natural sources.—The district of Tirhút, in Bengal, is most productive of nitre than any other place in India. It is most abundant in those parts containing a redundancy of carbonate of lime. An average sample of the soil analyzed by Mr. Stevenson (Journ. of the Asiatic Society of Bengal, vol. ii. p. 23) gave the following composition:

| Matter insoluble in three Mineral Acids | Silex | 50.0 |
| Matter soluble in ditto | Carbonate of Lime | 44.3 |
| Sulphate of Soda | 2.7 |
| Muriate of ditto | 1.4 |
| Nitrate of Lime | 0.9 |
| Nitrate of Potash | 0.7 |

100.0

"In the month of November the leonahs, or native manufacturers of saltpetre, commence their operations, by scraping off the surface from mud heaps, mud buildings, waste grounds, &c. where the saltpetre has developed itself in a thin white efflorescence, resembling frost rind. The saline earth being collected at the factories, the operator first subject
the process of solution and filtration. This is effected by a large mudd er, lined on the inside with stiff clay.” It has a false bottom of bboom, covered with close wrought grass mats, on which are placed getable ashes. Upon these the nitrous earth is laid. Water is then ded to dissolve the saline matters of the earth, and the solution thus tained, filtering through the mats, drops into the empty space between real and false bottom, and is conveyed away into an earthen receiver. its passage through the wood-ashes the carbonate of potash contained the latter re-acts on the nitrate of lime of the solution, and produces rate of potash and carbonate of lime. The solution is afterwards oparated in earthen pots, filtered, and put aside to crystallize. The pure nitre thus procured is termed dhouah: it contains from 45 to 70 cent. of pure nitrate of potash. It is re-dissolved and crystallized by native merchants, who supply the Calcutta bazaars, and when thus rified is called by the natives kalnee. (See Stevenson, op. cit.; also ia Jour. of Med. and Phys. Science, new series, vol. i. p. 10, 1836.) Saltpetre is imported into this country principally from Calcutta, but e comes from Madras. It is brought over in cloth bags which contain m 150 to 175 lbs. each. Its quality varies considerably. It is always re or less impure: but the common varieties, which have a dirty owish appearance, are termed rough or crude saltpetre, while the purer cleaner looking kinds are called East India refined. The loss which fers in refining, or in other words the impurities which it contains, technically designated refraction. This varies greatly in different rapes, but is usually between 5 and 15 per cent. (For the methods of ermining it, consult Dumas, Traité de Chimie, t. 2me. p. 762; and nde's Manual of Chemistry, 4th ed. p. 549.) Nitre is purified by repeated crystallization. When it has been dis-ed and crystallized once only it is called singly refined nitre: when ce, doubly refined. Its purity may be ascertained by testing it with ate of silver, chloride of barium, and oxalate of ammonia. The t detects the chlorides, the second the sulphates, and the third the careous salts.

From artificial sources.—The artificial preparation of nitre is prac-ed in several parts of Europe. The establishments in which it is rid on are called artificial Nitrières. The mode adopted varies, ever, in different places.

At Appenzel, a canton of Switzerland, nitre is formed from the urine animals. A hole is dug near to stables, and in this is put a sandy d of earth, which is kept moistened with the water running from the les. In two or three years this earth yields nitre.

In Sweden, where each landed proprietor is compelled to furnish a tain quantity of nitre, it is prepared as follows:—Decomposing animal vegetable matters, mixed with cinders, lime, or marl, are placed in ps (called nitre beds) under cover, the mass being occasionally moved, holes made in it, so that they are exposed to the air. From time t the they are watered with urine (a liquid containing more nitrogen than other animal substance.) At the end of two or three years the nitro- has combined with oxygen, and this with bases to form nitrates. By viation the salts may be separated, and any nitrate of lime present be converted into nitrate of potash by adding wood-ashes, which tain carbonate of potash.
In Prussia nitre-walls are employed instead of nitre-beds. They have two advantages,—they economize land, and they expose a large surface to the air, (Dumas, op. cit.)

**Properties.**—Nitrate of potash usually crystallizes in six-sided prisms with diëdral summits. Its primitive form is the right rhombo-prism, and, therefore, it has two axes of double refraction along which ray of light is not split into two.

*Double system of rings seen by looking through a slice of nitre (cut perpendicularly to the axis of the crystal) placed between two plates of tourmaline (cut parallel to the axis of the crystal).*

![Fig. 52](image)

![Fig. 53](image)

**Fig. 52** is seen when the plane of the axis of nitre is parallel or perpendicular to the plane of polarization.—**Fig. 53** is seen when the nitre is turned 45°.

When pure the crystals are transparent and colourless, have a sharp cooling taste, and undergo no change by exposure to the air. When heated nitrate of potash fuses, and when cast in moulds forms the *nitrum tabulatum*, or *sal prunelle* of the shops. At a strong red heat it is decomposed with the evolution of oxygen and the formation of hyponitrite of potash which when rubbed to powder and mixed with sulphuric acid emits fumes (composed of nitrous acid and binoxide of nitrogen.) One hundred parts of water at 32° dissolve 13·32 parts of this salt, but at 77° they dissolve 38 parts. During the solution cold is generated. In pure alcohol nitre is insoluble.

**Composition.**—Nitrate of potash has the following composition:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Wollaston</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid</td>
<td>48</td>
<td>52.9</td>
<td>53.332</td>
</tr>
<tr>
<td>Potash</td>
<td>102</td>
<td>100.0</td>
<td>100.000</td>
</tr>
</tbody>
</table>

The crystals contain interstitial water, but no water chemically combined.

**Characteristics.**—This salt is known to be a nitrate by the characters already detailed (p. 160) for this class of salts. That its base potash is shewn by the tests before mentioned (p. 274) for this substance.

**Physiological Effects.** *(a.) On vegetables.*—Nitrate of potash dissolved in 300 times its weight of water promotes vegetation; but a solution containing $\frac{1}{30}$ part of nitre is injurious to the growth of plants (Davy, *Agricult. Chemistry*).

*(b.) On animals generally.*—Orfila (*Toxicol. Gén.*) found that introduce into the stomach of dogs it acts as an irritant poison, and is capable of producing death, when it is not vomited, in doses of two or three drachms. Its operation is that of a narcotic-acrid poison. When applied to the cellular tissue it produces, according to this experimentalist, local effects only, and does not become absorbed. But Devergie (*Méd. Lég.*) stat
the authority of J. E. M. Smith, that half an ounce applied to the
high killed a dog in thirty-six hours. Eight ounces dissolved in a pint
water, and swallowed, killed a horse in twenty-four hours with all the
symptoms of violent intestinal irritation, (Moiroud, Pharm. Vétér.) Ve-
mirarians use nitre as a diuretic and refrigerant in doses of from two to
four drachms.

(c.) On man.—In very large doses (such, for example, as one ounce or
more) nitre has in several instances caused death; but the effects of it
were not uniform, since, in other cases, this quantity has not appeared to
have any very remarkable or obvious effect. For example, Dr. Christison
new an instance in which one ounce was taken without occasioning any
unpleasant symptom than vomiting; and it was retained on the
omach for above a quarter of an hour. In those cases where violent
symptoms followed the ingestion of it, the symptoms were twofold: on the
one hand, those indicating inflammation of the alimentary canal (such as
vomiting, and purging;) on the other hand, an affection of the ner-
vous system (marked by giddiness, convulsions, failure of pulse, tendency
to fainting, dilated pupil, insensibility, and palsy.) It is probable that
the operation of nitre is influenced by the quantity of aqueous liquid in
which the salt was dissolved, and that the more we dilute, the less power-
fully does it act as a poison. In no other way can we reconcile the dis-
septant statements in regard to the effects produced by an ounce of nitre.
If nitre (or any other neutral alkaline salt) be mixed with dark-coloured
blood out of the body, it communicates to it a florid or arterial
hue. Now as this salt, when taken into the stomach becomes absorbed,
it is not unreasonable to suppose that while mixed with the circulating
blood it might have an analogous effect. Dr. Stevens (Observations on
the Blood, p. 298) asserts, that in the last stage of fever, when the blood
is black, it has this effect. Moreover, he tells us (p. 154) that in a case
which occurred in America, where a person swallowed an ounce of nitre,
without mistake, in place of Glauber’s salts, the blood when drawn from a
vein was completely florid, and remained as fluid as if the nitre had been
added to it out of the body. (For some remarks on the effects of nitre
the blood, by Mr. Carlyon, see Med. Gaz. vol. viii. p. 626; and on its
use as a therapeutic agent, by Dr. Hancock, see Lancet for 1831-2,
vol. ii. p. 766.)

In moderate doses nitre acts as a refrigerant, diuretic, and diaphoretic.
Its refrigerant properties are best seen when the body is preternaturally
hot, as in febrile disorders. Mr. Alexander (Essays, pp. 105, et. seq.) in
his trials with it, made on himself, experienced a sensation of chilliness
after each dose, but he could not recognise by the thermometer any
minution of heat in the external parts of his body. He found in most
of his experiments that it had a powerful influence over the vascular
stem, and surprisingly diminished, in a very short period of time, the
number of pulsations. Thus on several occasions a drachm of this salt,
in a few minutes, reduced the frequency of his pulse from 70 to 60
sles. Sundelin (Heilmittel. Bd. 1. S. 59) says nitre diminishes the
gasm and plasticity of the blood perhaps by a chemical action on the

er and fibrin. Diuresis is another, and very generally observed
fact. As the nitre can be detected in the urine, its operation as a
uretic depends perhaps on the local stimulus which is communicated to
renal vessels while the nitre is passing through them. Like most of the
neutral salts of the alkalies, the continued use of it promotes alvine evacuations. Full doses frequently produce pain in the stomach. As a diaphoretic it is usually given in combination with emetic tartar.

Uses.—It follows from what has been now stated in regard to the physiological effects of nitre, that this substance is indicated when we wish to diminish preternatural heat, and to reduce the force and frequency of the pulse, as in febrile disorders, inflammatory affections (except perhaps those of the stomach, bowels, kidneys, and bladder), and haemorrhages (especially hæmoptysis.) In continued fever it is frequently given in combination with emetic tartar, and sometimes also with calomel. It is not often used as a diuretic, because its activity in the respect is not very great, but it is adapted for those cases which are accompanied with arterial excitement. In sore throat it is mixed with white sugar and gradually swallowed. A mixture of nitre and powdered gum has long been a favourite remedy for diminishing the scalding sensation of gonorrhœa. Nitre is rarely employed as an external agent, except as means of producing cold. Thus five ounces of nitrate of potash, with five ounces of muriate ammonia, dissolved in sixteen ounces of water will reduce the temperature 40° F.; that is, from 50° to 10°, according to Mr. Walker. Hence, therefore, we sometimes employ this mixture placed in a bladder, as an external application (see p. 133.)

On the belief that fever, cholera, and other malignant diseases, were produced by a deranged state of the blood, and that this derangement depended on, or consisted in, a diminution or entire loss of the saline parts of the blood, Dr. Stevens employed nitre, chloride of soda, and other alkaline salts, in the treatment of these diseases (see his Observations, pp. 296, 298, &c.) Nitre in large doses has been employed in the treatment of scurvy, and with considerable success, according to the statement of Mr. Cameron (Medico-Chirur. Review, March 1830, p. 483.)

Administration.—It may be given in doses of from ten grains to half a drachm in the form of powder mixed with sugar, or in solution. If administered as a refrigerant, it should be dissolved in water and immediately swallowed, in order that the coldness of the solution may assist the action of the salt. If employed as a diuretic, we ought to give liquid plentifully, and keep the skin cool.

Antidote.—No chemical antidote is known for this salt. In case of poisoning, therefore, we should remove the poison from the stomach as speedily as possible, and administer tepid emollient drinks. Opiate perhaps may be advantageously administered. The inflammatory symptoms are to be combated by the usual antiphlogistic measures.

Potas'sæ Chlo'ras.—Chlo'rate of Pot'ash.

History.—Chlorate of potash (also called oxymuriate or hyperoxymu riate of potash) was first procured by Mr. Higgins, who seems to have confounded it with nitrate of potash. In 1786 it was distinguished by Berthollet.

Preparation.—It is prepared by passing chlorine gas slowly through a cold solution of carbonate of potash placed in a Woullæ's bottle. The liquid is allowed to stand for twenty-four hours in a cool place, and is then found to have deposited crystals of chlorate of potash. These are to be drained, washed with cold water, dissolved in hot water, and re-crystallized.
When chlorine gas comes in contact with a solution of carbonate of potash, three salts are formed: chloride of potassium, hypochlorite of potash, and bicarbonate of potash.

**Products.**

<table>
<thead>
<tr>
<th>Agents.</th>
<th>Products.</th>
</tr>
</thead>
<tbody>
<tr>
<td>q. Carbonate Potash</td>
<td>140</td>
</tr>
<tr>
<td>Carb\textsuperscript{e}.</td>
<td>2 eq. Carb\textsuperscript{e}. A\textsuperscript{4}.</td>
</tr>
<tr>
<td>Potash 140</td>
<td>1 eq. Potash 48</td>
</tr>
<tr>
<td>Oxy.</td>
<td>1 eq. Hypochlorite, A\textsuperscript{4}.</td>
</tr>
<tr>
<td>Potash 140</td>
<td>1 eq. Hypochlorite Potb. 92</td>
</tr>
<tr>
<td>Chlorine</td>
<td>72</td>
</tr>
</tbody>
</table>

The proportion as the quantity of chlorine increases, the bicarbonate becomes decomposed: carbonic acid is evolved, and a further quantity of pochlorite of potash and chloride of potassium is produced.

When the solution is strongly charged with hypochlorite, the action the chlorine on the potash is somewhat changed: it abstracts the tassium from the potash, and thereby forms chloride of potassium, the oxygen thus set free combines with some hypochlorite of tash, and thereby converts it into the chlorate, the greater part of which crystallizes.

**Products.**

<table>
<thead>
<tr>
<th>Agents.</th>
<th>Products.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>144</td>
</tr>
<tr>
<td>Potash 192</td>
<td>4 eq. Potash 160</td>
</tr>
<tr>
<td>Hypochlorite Potash</td>
<td>92</td>
</tr>
</tbody>
</table>

The residual liquor contains a little chlorate, and a considerable quantity hypochlorite of potash and chloride of potassium (Souberain, Pharmacie, t. 2\textsuperscript{me}. p. 430.)

**Properties.** Chlorate of potash crystallizes in nearly rhomboidal plates, the primary form of which is an oblique rhombic prism. Its taste is cool, and somewhat similar to nitre. When rubbed in the dark it comes luminous. 100 parts of water at 32° F. dissolve 3.5 parts of chlorate: at 59° F. 6 parts: at 120° F. 19 parts.

**Characteristics.** This salt is known to be a chlorate by the following characters:—When heated, it fuses, gives out oxygen, and is converted into chloride of potassium: when thrown on a red-hot coal, it agitates—a property, however, common to several other salts. Sulphuric acid gives it an orange red colour, evolves the chlorous acid (oxide of chlorine), known by its yellow colour, and great explosive power when heated. Rubbed with sulphur or phosphorus it explodes readily. Mixed with hydrochloric acid and then with water, it forms a taching liquid. The base of the salt is known by the tests for potash, already mentioned.

**Composition.** It is an anhydrous salt.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloric Acid</td>
<td>1</td>
<td>76</td>
</tr>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>Chlorate of Potash</td>
<td>1</td>
<td>124</td>
</tr>
</tbody>
</table>

**Impurity.** Chloride of potassium is the usual impurity. This may be detected by a solution of nitrate of silver producing the white chloride of silver. The pure chlorate potash produces no obvious change in state of silver.
Physiological Effects. (a.) On animals generally.—In one series of experiments, Dr. O'Shaughnessy (Lancet for 1831-2, vol. i. p. 366) injected from 10 to 60 grains of chlorate of potash, dissolved in three ounces of tepid water, into the cervical vein of a dog: no ill effect was observed: the pulse rose in fulness and frequency, the urine was found a short time to contain traces of the salt, and the blood of the tracheal veins had a fine scarlet colour. In another series of experiments the animal was stupified by hydrocyanic acid or hydrosulphuric acid gases, the brachial vein was opened, and a few drops of excessively dark blood could with difficulty be procured. Half a drachm of the chlorate dissolved in water of the temperature of the blood was injected slowly in the jugular vein: the pulsation of the heart almost immediately began to return, and in the course of eight minutes scarlet blood issued from the divided brachial veins. In twenty minutes the animal was nearly recovered, and passed urine copiously, which was found to contain the chlorate.

(b.) On man.—The action of this salt on man requires further investigation. It appears to be refrigerant and diuretic, analogous to that of nitrate of potash. Wöhler and Stehberger have recognized chlorate of potash in the urine of patients to whom it had been exhibited, so that does not appear to undergo any chemical change in its passage through the system. This fact is fatal to the hypothesis of the chemico-physiologists, who fancied that it gave oxygen to the system, and was, therefore, well adapted for patients affected with scrofulous conditions, which were supposed to depend on a deficiency of this principle. Excessive doses of the chlorate, like those of the nitrate, would probably produce an affection of the nervous system; but I am not acquainted with any satisfactory case in proof. Duchateau (Merat and De Lens, Dict. Mat. Med.) says that eighteen grains taken thrice a day caused convulsions and delirium, but the observation is probably erroneous: for others have not experienced these effects, in much larger doses. Dr. Stevens (On the Blood, p. 155) says chlorate of potash gives a beautiful arterial colour to the venous blood, and reddens the gums much faster than mercury.

Uses.—Chlorate of potash was originally employed as a medicine of supplying oxygen to the system, where a deficiency of that principle was supposed to exist. With this view it was successfully administered by Dr. Garnett (Duncan's Annals of Medicine, 1797) in a case of chronic scrofulous disease and liver complaints as a substitute for mercurials, who beneficial effects were thought to depend on the oxygen which they communicated to the system (see the reports of Mr. Cruikshank and Dr. Wittman, in Dr. Rollo's Cases of Diabetes Mellitus, 2d ed. pp. 504 and 563; also Dr. Chisholm's letter in the same work, Preface, p. x). It has also been tried in cases of general debility, on account of its suppositive effects, but failed in the hands of Dr. Ferrier (op. cit.). In a case of dropsy under the care of the latter gentleman it operated successfully as a diuretic. More recently, it has been used by Dr. Stevens (On the Blood, p. 296) and others, as a remedy for fever, cholera, and other malignant diseases, which, he supposed, depend on a deficiency of saline matters in the blood, but as it was usually employed in conjunction with chloride of sodium (see the article on this salt, further on) and carbon.
soda, it is impossible to determine what share the chlorate had in pro-
cucing the beneficial effects said to have been obtained by what is
lled the saline treatment of these diseases.
It appears, then, that all the uses of this salt have been founded on
ertain views of chemical pathology, some of which are now considered
tenable. It is very desirable, therefore, that some person, unbiased
 theoretical opinions, would carefully investigate its effects and uses,
ich I am inclined to think have been much overrated.

ADMINISTRATION.—The usual dose of it is from ten or fifteen grains to
half a drachm. Dr. Wittman, in one case, gave 160 grains daily, with a
de hydrochloric acid immediately after it, to decompose it: the effects
ere hot skin, headache, quick, full, and hard pulse, white tongue, and
gmentation of urine.

Potas'sae Carbonas.—Carbonate of Pot'ash.

HISTORY.—It is probable that the ancient Greeks, Romans, and
yptians, were acquainted with this salt. Pliny (Hist. Nat. lib. xiv.
d xxviii.) describes some of the uses of wood-ashes, and mentions a
of them (cineris lixivium). For a long period carbonate of potash
as confounded with carbonate of soda. Geber (Invent. of Verity, ch. iv.),
the eighth century, describes the method of procuring it by the com-
osition of tartar. It has been known by various names; such as, salt of
lar, mild vegetable alkali, fixed nitre, and subcarbonate of potash.

NATURAL HISTORY.—Reuss (Gairdner, On Mineral Springs, p. 18)
and carbonate of potash in the waters of the Wissokow, and in the
alybeate of Twr.

It is formed, during the combustion of inland plants, by the decom-
ion of the vegetable salts of potash (the acetate, the malate, and the
late, but principally the first). Hence it is procured in great abun-
ze from wood-ashes. In some few cases it has been supposed to exist
ly formed in plants, as in a fern referred to by Mr. Parkes (Chemical
ays, vol. ii. p. 17), the expressed juice of which is employed by the
weavers of Yorkshire, in the cleansing of cloth at the fulling mills.

PREPARATION.—It is principally obtained from wood-ashes (cineres
etabilium, seu cineres e lignis combustis). These are procured by
ming wood piled in heaps on the ground, sheltered from the wind, or in
s.—[For an account of the proportion and composition of wood-ashes,
Berthier, Traité des Essais, t. 1er. p. 259).] The soluble constituents
the ashes are, carbonate, sulphate, phosphate, and silicate of potash,
lorides of potassium and sodium. The insoluble constituents
arbonate and subphosphate of lime, alumina, silica, the oxides of
and manganese, and a dark carbonaceous matter. In America the
es are lixiviated in barrels with lime, and the solution evaporated in
ge iron pots or kettles, until the mass has become of a black colour,
d of the consistence of brown sugar. In this state it is called by the
american manufacturers black salts (cineres clavellati crudit). The dark
our is said by Dumas to be owing to ulmate of potash.

To convert this substance into the pot-ash of commerce (cineres clavell-
eri calcinata), it is heated for several hours, until the fusion is complete,
the liquid becomes quiescent. It is then transferred by large iron
es into iron pots, where it congeals in cakes. These are broken up,
packed in tight barrels, and constitute the pot-ashes of commerce. Its colour varies somewhat, but it is usually reddish, in consequence of the presence of sesquioxide of iron.

To make the substance called *pearl-ash* (*potassa impura*, Ph. L) the mass called black salts, instead of being fused, is transferred from the kettles to a large oven-shaped furnace, so constructed that the flame made to play over the alkaline mass, which in the meantime is stirred by means of an iron rod. The ignition is in this way continued until all combustible impurities are burnt out, and the mass, from being black, becomes dirty bluish white: this is pearl-ash (*United States Dispensatory*).

The following table shows the composition of various kinds of pot-ash and pearl-ash, according to Vauquelin (*Ann. de Chim.* xl. 273):

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>American Potash</td>
<td>857</td>
<td>154</td>
<td>20</td>
<td>2</td>
<td>119</td>
</tr>
<tr>
<td>Russian Potash</td>
<td>772</td>
<td>65</td>
<td>5</td>
<td>56</td>
<td>254</td>
</tr>
<tr>
<td>American Pearlash</td>
<td>754</td>
<td>80</td>
<td>4</td>
<td>6</td>
<td>308</td>
</tr>
<tr>
<td>Potash of Trèves</td>
<td>720</td>
<td>165</td>
<td>44</td>
<td>24</td>
<td>199</td>
</tr>
<tr>
<td>Dantzie Potash</td>
<td>603</td>
<td>152</td>
<td>14</td>
<td>79</td>
<td>304</td>
</tr>
<tr>
<td>Potash of Vosges</td>
<td>444</td>
<td>148</td>
<td>510</td>
<td>34</td>
<td>16</td>
</tr>
</tbody>
</table>

In this table it will be observed, that the American pot-ash contains the largest quantity of caustic potash: this arises, probably, from the use of lime in its manufacture. Moreover, pearl-ash contains more carbonate of potash than pot-ash: this must arise from the absorption of carbonic acid during its preparation.—[For the mode of estimating the quantity of alkali present, see Mr. Faraday’s *Chemical Manipulation, or Alkalimetry.*] The pot-ash and pearl-ash employed in this country are principally imported from the British North American colonies, from Russia, and from the United States of America.

In the *Pharmacopoeia* carbonate of potash is directed to be prepared as follows:—Dissolve two pounds of impure carbonate of potash (pearl-ash) in a pint and a half of water, and strain; then pour it off into a proper vessel, and evaporate the water, that the liquor may thicken; then stir constantly with a spatula until the salt concretes. In this process the earthy impurities insoluble in water are got rid of. The same authority also states, that a purer carbonate may be prepared by heating the crystals of the bicarbonate to redness.

The high price of pearl-ash has occasionally led to the manufacture of carbonate of potash from *sal enium* (bisulphate of potash), by heating in a reverberatory furnace with charcoal. This yields sulphuret of potassium, in consequence of the carbon deoxidizing the bisulphate. If roasting, the sulphuret is decomposed, and converted into the carbonate of potash; the sulphur being dissipated, and the potassium combin'd with oxygen and carbonic acid.

**Properties.**—Carbonate of potash (the *salt of tartar* of the shops) usually kept in a granular condition, on account of the difficulty of crystallizing it. It is white, inodorous, and strongly alkaline to the taste. It reacts powerfully as an alkali on turmeric or infusion of red-cabbage. It is fusible at a red heat; has a strong affinity for water, so that by exp
Pure carbonate of potash may be prepared by the combustion of bitartrate of potash and nitre (forming what is called white flux), lixiviating, concentrating by evaporation, and crystallizing. The primary form of the salt is a rhomboic octahedron.

**Characteristics.—**It is known to be a carbonate by its effervescing with the strong acids, and by a solution of it causing a white precipitate (luble in acetic acid) with lime water or with chloride of barium. That is a potash salt is determined by the tests for potash already mentioned. On the bicarbonate of potash it is distinguished by its causing a brick-red precipitate with a solution of bichloride of mercury, the precipitate being percarbonate of mercury. Sulphate of magnesia produces a white precipitate with the carbonate of potash, and not with the bicarbonate. This test, however, will not recognise the carbonate when mixed with large quantity of bicarbonate.

**Composition.—**Mr. Phillips (Pharmacopœia) says, one hundred parts the carbonate of potash of the shops loses about 16 parts of water when heated to redness. Hence supposing the carbonate to have been (which that of commerce never is) its composition would be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>57.6</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>1</td>
<td>22</td>
<td>26.4</td>
</tr>
<tr>
<td>Water</td>
<td>13</td>
<td>13.5</td>
<td>16.0</td>
</tr>
<tr>
<td>Pure Granulated Carb. Potash</td>
<td>1</td>
<td>83.5</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The pure crystallized salt contains two equivalents of water of crystallization, and its equivalent weight, therefore, is 88.

**Impurities.—**The ordinary impurities in this salt are silicie acid, the chlorides, and sulphates. The first is detected by supersaturating with drochloric acid, evaporating, and igniting the residue: the silicie acid is insoluble in water. The other impurities are detected by supersaturating the salt with nitric acid: if the resulting solution give a white precipitate with nitrate of silver, the presence of chloride is to be inferred: if it produce a white precipitate with chloride of barium, a sulphate is present.

**Physiological Effects.—**Its effects are in quality precisely those of astringent potash already described, but their intensity is much less, on account of the presence of carbonic acid, which diminishes the alkaline properties of the base. When it is taken into the stomach in large quantities, it acts as a powerfully caustic poison, sometimes inducing death twelve hours, and producing symptoms similar to those caused by the general acids: at other times, however, the patient recovers from the immediate effect of the alkali, but in consequence of the altered condition of the alimentary canal the assimilative process cannot be carried on; and dragging on a miserable existence for a few weeks, the unfortunate sufferer dies of absolute starvation. And lastly, in some cases, the caustic irritation of the poison is principally confined to the esophagus, causing indigestion and death. In one case, related by Sir Charles Bell (Surgical
Observations, part i. p. 82), a patient swallowed soap lees; this produce inflammation, which terminated in stricture. She lingered for 20 years and died literally starved. Several other cases have been detailed (Christison, On Poisons.) A weak solution of carbonate of potash produces no change in the sanguineous particles drawn from the body; saturated solution slightly and gradually diminishes their size.

Uses.—This salt is employed in medicine in most of the cases already mentioned when describing the uses of caustic potash. For example, as an antacid in dyspeptic affections; as a diuretic; as an antacid in the form of lithiasis which is accompanied with an increased secretion of lithic acid, or the lithates; in those forms of inflammation in which there is a tendency to the formation of false membranes; in gout, &c. Mixed with cochineal it is a popular remedy for hooping-cough. Externally, it has been applied in the form of a solution to wounds; as an injection in gonorrhoea; as a collyrium in some affections of the cornea, &c. Lastly, it is sometimes employed in the manufacture of the common effervescent draught, made with either the citric or tartaric acid. Twenty grains of carbonate of potash are saturated by about 17 grains of the citric acid of commerce, by 18 grains of tartaric acid, or by 3iv. of lemon juice.

Administration.—It may be given either in the solid or liquid state. In the solid state it is given in doses of from gr. x to 5ss. The doses of the liquor potassse carbonatis of the Pharmacopoeia is from ten minims to a fluidrachm.

Antidotes.—When swallowed as a poison, the antidotes are oils of acids, as already mentioned for the caustic potash.

Potas'sae Bicar'bonas.—Bicar'bonate of Pot'ash.

History.—This salt, formerly called carbonate of potash or aereat kali, was first prepared by Cartheuser in 1752.

Preparation. (a) Process of the Pharmacopoeia.—In the London Pharmacopoeia we are directed to pass carbonic acid (generated by the action of equal weights of sulphuric acid and water in powdered chalk) through a solution of six pounds of the carbonate in a gallon of distilled water, to saturation. Apply a gentle heat, so that whatever crystals have formed may be again dissolved. Then set the solution aside that crystals may be formed, which are to be dried.

In this process, each equivalent of carbonate of potash unites with an additional equivalent of carbonic acid, and thereby forms the bicarbonate. The silicic acid is separated partly while the carbonic acid is passing through the solution, and partly during the crystallization of the bicarbonate.

(b) Cartheuser’s Process.—In the Pharmacopée Raisonnée of MM. Henry and Guibourt the following directions are given for performing this process:—Dissolve 500 parts of (pure) carbonate of potash in 1000 parts of distilled water, and filter: place the solution in a porcelain container in a salt-water bath, and gradually add 300 parts of pulverized carbonate of ammonia; slightly agitate the liquor until only a feeble disengagement of ammonia is perceived, then filter over a heated vessel and put aside to cool. The proportions employed by Geiger (Handbuch d. Pharm.) are somewhat different: they are, a pound of carbonate of potash, sixteen ounces of water, and six ounces of carbonate of ammonia. Mr. Brande (Manual of Chemistry) says Cartheuser’s process is more expensive than that of the Pharmacopoeia.
In this process the volatility of the ammonia, joined to the affinity of carbonate of potash for more carbonic acid, causes the decomposition of the sesquicarbonate of ammonia: the ammonia with a small portion of carbonic acid is disengaged, while the remaining acid converts the carbonate into the bicarbonate of potash.

**Properties.**—It is a crystalline, colourless solid, the primary form of the crystal is, according to Mr. Brooke, a right oblique-angled prism. Insidious, has an alkaline taste, and reacts very feebly as an alkali. It is impregnated with vegetable colours. It is soluble in four times its weight of water, at 1°F., but is insoluble in alcohol. When exposed to the air it undergoes no change. When exposed to a red heat it gives out half its carbonic acid, and becomes the carbonate.

**Characteristics.**—The presence of carbonic acid and potash in this is known by the tests for these substances before mentioned. From carbonate of potash it is best distinguished by a solution of chloride of mercury, which causes a slight white precipitate with it: whereas with the carbonate it causes a copious brick-dust precipitate. Carbonate of magnesia will not recognise the freedom of bicarbonate from potash, as I have before stated (p. 301.)

**Composition.**—The composition of this salt is as follows:

<table>
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<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>47.58</td>
<td>48.92</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>2</td>
<td>44</td>
<td>43.60</td>
<td>42.01</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>8.82</td>
<td>9.07</td>
</tr>
<tr>
<td>Crystallized Bicarbonate Potash</td>
<td>1</td>
<td>101</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Impurities.**—The presence of chlorides and sulphates may be recognised in the way described when speaking of carbonate of potash. Chloride of mercury may be employed to detect any carbonate of potash, with which it would form a brick-dust coloured precipitate.

**Physiological Effects.**—The effects of this salt are similar to those of the carbonate of potash, except that its local action is much less salutary, in consequence of the additional equivalent of carbonic acid; and the alkaline effect on the system is equally energetic, so that it is an exceedingly eligible preparation in lithiasis and other cases where we must either modify the constitutional, and not its local, action.

**Uses.**—It may be employed for the same purposes that we use caustic soda (vide potash), except that of acting as an escharotic. Thus it is as an antacid, to modify the quality of the urine, in plastic inflammations, glandular diseases, affections of the urinary organs, &c. But the most frequent use is that for making effervescing draughts, with either citric or tartaric acid. The proportions are as follows:—20 grains of carbonate of potash will saturate about 14 grains of the citric acid of commerce, 15 grains of tartaric acid, or 3ijss. of lemon juice. In the latter a preparation, called lemon and kali, is kept: it is composed of 1 dr. of dry citric acid, and the bicarbonate of potash. It is used as an imporaneous effervescing draught. As it abstracts water from the atmosphere, it must be kept in a well-stopped bottle. Where there is great irritability of stomach, I believe the effervescing draught, made with bicarbonate of potash and citric acid, to be more efficacious than that made with carbonate of soda and tartaric acid, the dissolving citrate of potash being, in my opinion, a much milder prepara-
tion than the tartrate of soda. The citrate promotes slightly the secretion of the alimentary canal, the cutaneous transpiration, and the renal secretion: and like other vegetable salts of potash, renders the urine alkaline.

Administration.—This salt may be given in doses of from gr. x. to gr. xv. or to the extent of half a drachm, or even a drachm.

Liquor Potassae Effervescent (Ph. L.)—The effervescing solution of (bicarbonate of) potash is ordered to be prepared by dissolving a drachm of bicarbonate of potash in a pint of water, and passing into the solution carbonic acid compressed by force, more than sufficient for saturation. The solution is to be kept in a well-stopped vessel. This preparation has been introduced as an agreeable form for exhibiting carbonate of potash, without diminishing its constitutional operation.

Potassae Acetos.—Acetate of Potash. +

History.—It appears to have been first clearly described by Raymond Lully in the thirteenth century, and has been known by several appellations, such as terra foliata tartari, diuretic salt, &c.

Natural History.—Geiger (Handbuch der Pharmacie) says this salt is found in some mineral springs. It probably exists in most plants which, by incineration, yield carbonate of potash. The sap of the elm and of most trees, Winter's bark, linseed, senna leaves, the rhizome of ginger, &c. are said to contain it.

Preparation.—It is prepared by adding a pound of carbonate of potash to twenty-six fluidounces of acetic acid (Ph. L.) mixed with twelve fluidounces of distilled water, or sufficient acid to saturate the carbonate. Evaporate the strained liquor in a sand-bath, the heat being cautiously applied until the salt is dried.

In this process the acid unites with the potash of the carbonate, and disengages carbonic acid.

Properties.—It is usually met with as a colourless, white solid, with a foliated texture (which is given to it by fusion and cooling), odourless, having a pungent saline taste, and a soapy feel. It is exceedingly deliquescent, and, therefore, ought to be preserved in a well-stopped bottle. It is very soluble both in water and alcohol; indeed, in water, it is one of the most soluble salts we are acquainted with. At 60°, 100 parts of the salt will dissolve in 102 parts of water. When heated, it fuses and is decomposed into pyroacetic spirit, and carbonate of potash. One equivalent of this spirit contains the elements of one equivalent of acetic acid, minus those of one equivalent of carbonic acid.

Characteristics.—(See the tests for the acetates, p. 222, and for potash, p. 274).

Composition.—Its composition is as follows:

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>48.5</td>
<td>50.15</td>
</tr>
<tr>
<td>Acetic Acid (dry)</td>
<td>1</td>
<td>51</td>
<td>51.5</td>
<td>49.85</td>
</tr>
<tr>
<td>Acetate of Potash</td>
<td>1</td>
<td>99</td>
<td>100.0</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Purity.—It should be white and perfectly neutral. Frequently, however, it reacts as an alkali, owing to a slight excess of potash. The presence of chlorides may be detected by nitrate of silver; of sulphate by chloride of barium; of metals, by hydrosulphuric acid or ferrocyanide of potassium.
PHYSIOLOGICAL EFFECTS.—Two or three drachms cause purging, which sometimes accompanied with griping. In smaller doses, more especially largely diluted, this salt acts as a mild diaphoretic. In its passage to the kidneys it becomes decomposed, and converted into the carbonate of potash, which may be detected in the urine. Probably the pulmonary cretions of those who employ it also become impregnated with this salt, since it has been said that in persons with delicate lungs it acts as irritant to these organs.

USES.—In this country it is rarely employed, except as a diuretic in scirrhous complaints. On the continent, however, it is administered in various other diseases, as an alterative or resolvent, in scirrhus of the breast, chlorosis, and visceral and glandular enlargements. It may be employed, in the lithic acid diathesis, to render the urine alkaline. It is of course exceedingly improper where phosphiatic deposits are observed in the urine.

ADMINISTRATION.—It is given as a diuretic in doses of from a scruple a drachm and a half, dissolved in some mild diluent. In larger doses, two or three drachms, it acts as a purgative.

**Potassa Bitartrae.**—Bitartrate of Potash.

HISTORY.—In its impure form, as a deposit from wine, it must have been known at a very early period. "It is called tartar," says Paracelsus, "because it produces oil, water, tincture, and salt, which burn the soul as hell does." Scheele, in 1769, first explained its nature. Its synonyms are cream of tartar, superbitartrate of potash, and acidulous bitartrate of potash.

NATURAL HISTORY.—It is a constituent of many vegetables: thus it is found in grapes, tamarinds, Cetraria islandica, &c.

PRODUCTION.—All the bitartrate of commerce is obtained during the natural fermentation. It exists in solution in grape juice; but being only slightly soluble in a mixture of alcohol and water, it deposits during fermentation (that is, when alcohol is produced), and forms a crust on the sides of the cask. In this state it is known in commerce under the name of crude tartar (tartaratus crudus), or argol, and which is called white or red (tartaricus albus vel tartaricus ruber), according as it is obtained from white or red wine.

Argol, or crude tartar, occurs in crystalline cakes of a reddish colour, it is composed of the bitartrate of potash, tartrate of lime (and sometimes racemate of potash), colouring and extractive matter, &c.

At Montpellier, bitartrate of potash is procured thus:—Argol is boiled in water, and the solution allowed to cool, by which a deposit of crystals obtained; these are washed with cold water, and dissolved in boiling water, containing charcoal and alumina (clay); the latter substances being employed to remove the colouring matter with which they precipitate. A clear liquor is allowed to cool slowly, by which crystals of the bitartrate are formed. These constitute the tartaratus depuratus or crystal tartar of the older chemists. If a hot saturated solution of tartar be first cooled, the surface of the liquid becomes coated by a layer of very fine needles of bitartrate: hence this crust was called cream of tartar (cremora tartari.)
Properties.—As met with in commerce, this salt forms a white crystalline mass, without odour, but having an acidulous and gritty taste. The primary form of the crystals is a right rhombic prism. It is unaltered by exposure to the air; but when heated, it decomposes, swells up, evolves various volatile products, gives out an odour of caromone and is converted into black flux (fluor niger), —a compound of charcoal and carbonate of potash. If the bitartrate be deflagrated with nitrate of potash, the residue is white flux (fluor albus), or carbonate of potash. Bitartrate of potash is very slightly soluble in water, and is insoluble in alcohol.

Characteristics.—One character of this salt is derived from the phenomena attending its conversion into black flux, as above mentioned. A black flux be digested in water we obtain a solution of carbonate of potash, known by the properties before mentioned (p. 301.) Another character of the bitartrate is its slight solubility in water, and the solution reddening litmus. The addition of caustic potash increases its solubility, whereas alcohol diminishes it. Acetate of lead added to a solution of the bitartrate forms a copious white precipitate; lime water has the same effect. Mixed with alkaline carbonates it produces effervescence. Boracic acid, or borax, very much increases the solubility of this salt in water, forming what has been termed soluble cream of tartar (crema tartari solubilis), or tartarboraczatus of some writers.

Composition.—Crystallized bitartrate of potash has the following composition:

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>25.3</td>
<td>24.80</td>
</tr>
<tr>
<td>Tartaric Acid</td>
<td>2</td>
<td>132</td>
<td>70.0</td>
<td>70.45</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>4.7</td>
<td>4.75</td>
</tr>
<tr>
<td>Crystallized Bitartrate, Potash.</td>
<td>1</td>
<td>189</td>
<td>100.0</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Impurity.—Bitartrate of potash usually contains from 2 to 5 per cent. of trtarate of lime, and hence a little carbonate of lime may be detected in black flux. This is of no material consequence in a medicinal point of view. If the powdered bitartrate be adulterated with either alum or bisulphate of potash, the fraud may be detected by chloride of baryum, which causes a white precipitate (sulphate of baryta) insoluble in nitric acid.

Physiological Effects.—When taken in small doses, diluted with water, it acts as a refrigerant and diuretic: in larger doses (as two or three drachms) it purges, and frequently creates flatulence and griping. By continued use it disorders the digestive functions, and causes emaciation, most probably from defective nutrition. In excessive doses it produces inflammation of the stomach and intestines. A fatal case has been recorded by Mr. Tyson (Med. Gaz. vol. xxi. p. 177.) A man, relieve the effects of drunkenness, swallowed four or five table-spoonfuls of cream of tartar. It caused violent vomiting and purging, and other symptoms of gastro-enteritis, and pain in the loins. The thighs and legs appeared paralyzed. He died on the third day. On a post-mortem examination the stomach and intestines were found inflamed.

Uses.—Bitartrate of potash is frequently employed in the form imperial or cream of tartar whey, as a refrigerant drink in febrile and inflammatory diseases. It allays thirst, diminishes preternatural heat
The deliquesces as a diuretic in dropsical complaints it is used in the same way. As a purgative it is not usually exhibited alone, but, in general, with jalap, sulphur, senna, or some other purgative. In dropsical complaints, a very valuable hydragogue cathartic is a mixture of jalap and bitartrate of potash. In skin diseases and affections the rectum (as piles, stricture, and prolapsus) a very useful purgative in an electuary composed of sulphur, bitartrate of potash, and confection of senna. An effervescing aperient may be prepared by mixing three drachms of the bitartrate with two and a half drachms of carbonate of lead: the resulting salt is the potash-bitartrate of soda. As a tooth-powder, bitartrate of potash is sometimes used on account of its gritty qualities:

**Administration.**—As a hydragogue cathartic the dose is from four to eight drachms: as an aperient, one or two drachms: as a diuretic, in treated doses of a scruple to a drachm. Imperial (tisana imperialis) is made by adding boiling water to cream of tartar, and flavouring with lemon-peel and sugar. It may be taken, ad libitum, as a refrigerant drink in febrile complaints. Cream of tartar whey (serum lactis tartaratum) is made by adding about two drachms of bitartrate to a pint of milk. It may be diluted with warm water, and taken in dropsical complaints.

The compound powder of jalap (pulvis jalape compositus) of the London Pharmacopoeia is composed of three ounces of jalap, six ounces of the bitartrate, and two drachms of ginger: the dose is from a scruple to a drachm in dropsical complaints.

**Potassæ Tartras.**—Tartrate of Potash.

**History.**—This salt was known to Lemery. It has been termed tartarized-tartar, tartarized kali, soluble tartar, or vegetable salt.

**Preparation.**—It is readily prepared by saturating the bitartrate with carbonate of potash. The proportions employed in the London Pharmacopoeia are sixteen ounces (or as much as may be sufficient) of carbonate of potash dissolved in six pints of boiling water, and three ends of powdered bitartrate of potash. After boiling, strain, and evaporate until a pellicle forms: then set aside to crystallize.

In this process the excess of acid in the bitartrate is saturated by the ash of the carbonate: the carbonic acid escapes.

**Properties.**—It is usually met with in the shops in a granular state, but ought to be crystallized. The primary form of the crystals is a tetra- or oblique-angled prism. To the taste this salt is saline, and somewhat bitter. It deliquesces when exposed to the air, and is soluble in a given weight of water at 50°; the solution decomposes by keeping.

**Characteristics.**—When heated to redness, it is decomposed, leaving a residue charcoal and carbonate of potash. A solution of the tartrate fuses a white precipitate with solutions of acetate of lead, nitrate of silver, and chloride of calcium; the precipitates being soluble in nitric acid. When heated, the salt evolves the odour of caramel. If an excess of any strong acid (as the sulphuric) be added to a solution of this salt, crystals of the bitartrate. Hence acids, and most acidulous substances, are incompatible with it: as also are tamarinds. The tartrate is
readily distinguished from the bitartrate by its deliquescent property, its greater solubility, and its want of acidity.

Composition.—The following is the composition of this salt:

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<tr>
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<tbody>
<tr>
<td>Potash</td>
<td>1</td>
<td>48</td>
<td>42·1</td>
<td>41·31</td>
</tr>
<tr>
<td>Tartaric Acid.</td>
<td>1</td>
<td>66</td>
<td>57·9</td>
<td>58·69</td>
</tr>
<tr>
<td>Tartrate of Potash</td>
<td>1</td>
<td>114</td>
<td>100·0</td>
<td>100·00</td>
</tr>
</tbody>
</table>

Impurity.—It may contain excess of acid or base, either of which easily recognised; the one by litmus, the other by turmeric. The sulphates may be detected by chloride of barium throwing down a white precipitate insoluble in nitric acid.

Physiological Effects.—This salt is a gentle purgative, analogous its action to the sulphate of potash, from which it differs in being mild in its operation, and partially digestible; for, like the other vegetable salt of the alkalies, it is decomposed in the system, and converted into its carbonate, in which state it is found in the urine.

It is said to have the power of preventing the griping of other more active cathartics; as senna and scammony; but, from my own personal observations, I doubt the correctness of this statement.

Uses.—It is employed as a mild purgative in dyspepsia, at the commencement of diarrhœa, in some liver complaints, &c. Sometimes it is used as an adjunct to other more active purgatives: as the infusion of senna.

Administration.—It may be given in doses of from two to three drachms to half an ounce, or even an ounce.

Order 11.—Compounds of Sodium.

So'dii Chlor'idum.—Chlor'ide of So'dium.

History.—As this salt is a necessary and indispensable seasoning of our food, it doubtless must have been known to, and employed by, the first individuals of our race. The earliest notice of it occurs in the writings of Moses, (Gen. xix. 26; Lev. ii. 13) and Homer (Iliad, lib. 214). It has received various names, such as common salt, culinary salt, and muriate or hydrochlorate of soda.

Natural History.—It occurs in both kingdoms of nature.

(a.) In the inorganic kingdom.—An enormous quantity of this salt contained in the waters of the ocean. At an average calculation, water contains 2·5 per cent. of chloride of sodium (vide various analyses of this fluid in Thomson’s System of Chemistry, 6th ed. vol. iii. p. 16). It is found also in great abundance in mineral waters (Gairdner, Mineral Springs, p. 12). It has not hitherto been found in the old stratified rocks (De la Beche, Researches in Theoret. Geol. p. 31), but met with in all the later formations. Thus Mr. Featherstonhaugh (P. Mag. N. S. vol. v. p. 139; vol. vi. p. 75; and vol. vii. p. 198) states that salt or brine springs occur in certain parts of the United States, in old transition slate rocks. Salt springs occur in various parts of England in the coal measures (Bakewell, Introd. to Geology, 4th ed. p. 252). The rock salt of Cheshire, and the brine springs of Worcestershire, occur,
old red sandstone group (Trans. Geol. Society, vol. i. p. 38, and vol. ii. 94). The salt of Ischel, in the Austrian Alps, belongs to the oolitic group (Sedgwick and Murchison, Phil. Mag. N. S. vol. viii. p. 102), as also that found in the lias in Switzerland (Bakewell, op. cit. p. 253). The immense mass or bed of salt near Cardona in Spain, and which has been described by Dr. Traill (Trans. Geol. Society, vol. iii. p. 404) occurs in the cretaceous group (De la Beche, op. cit. p. 293). The salt of Wieliczka, near Cracow, belongs to the supracretaceous group (De la Beche, p. 270). Lastly, in the Crimea, salt is said to be daily accumulating in the inland lakes.

(b.) In the organized kingdom.—It is found in plants which grow by the sea side, in the blood and urine of man, &c.

Preparation.—The salt consumed in this country is procured by the evaporation of the water of brine springs. The salt districts are Northwich, Middlewich, and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and Droitwich, in Worcestershire. In Cheshire the rock salt (called so fossil salt, sal fossiliis or sal gemmæ) constitutes two beds which vary in thickness from 4 to 130 feet, and are separated by a bed of clay, 10 or 12 feet thick; the uppermost bed of salt being 30 or more feet from the surface of the earth. It is for the most part a reddish colour, but is also met with in transparent colourless masses. It is called in commerce as salt, and is largely exported for purification. Brine springs are let with both above and below the level of the beds of rock salt.

The brine is pumped up into cisterns or reservoirs, from which it is drawn when wanted into large, oblong, wrought-iron evaporating pans, which are usually worked with four or more fires. If the brine be not completely saturated with chloride of sodium, a little rock salt is added to it. By the evaporation of the water the salt deposits in crystals. The impurities separate in the form of a scum (which is removed by a skimming dish), and of a sediment called pan-scale, or pan-scratch. As all parts of the pan are not equally heated, the crystallization of the salt takes place in different parts at different times, and consequently in the same grainy or crystals vary considerably in size. The small-grained salt is formed by the strongest heat, and constitutes the butter, stoved, mp, or basket salt of commerce: while the larger crystals, forming the dry and fishery salts of commerce, are deposited in the coolest part of the pan. (For further information on the manufacture of common salt, consult Birk's Dictionary of Chemistry, vol. ii. p. 118; Holland's Agricultural Survey of Cheshire; Mr. Furnival's Wharton and Marston Patent Salt Refineries, 1836; Dr. Brownrigg's Art of making Common Salt, 1748.)

In some parts of the world chloride of sodium is obtained from seawater: but the mode of extracting it varies according to circumstances. In warm countries it is procured by solar evaporation, and is then called by salt. In cold countries congelation is resorted to as a means of concentrating sea water; for when a weak saline solution is exposed to treat cold, it separates into two parts; one almost pure water, which freezes, and the other which remains liquid, and contains the larger proportion of salt. Another method of concentration is by gradually freezing: these are skeletons of houses, in which the water is pumped up, and allowed to fall on heaps of brushwood, thorns, &c., by which it is divided and agitated with the air, and evaporation promoted. The further concentration is effected by heat.
Properties.—It crystallizes in colourless cubes, or more rarely in regular octahedrons. In the salt pans the little cubes are frequently aggregated as to form hollow, four-sided pyramids, whose sides have some resemblance to a series of steps: these are technically called hoppers. The specific weight of salt is 2·17. The taste is pure salina. When free from all foreign matters, chloride of sodium is permanent in the air, but ordinary salt is slightly deliquescent, owing to the presence of small quantities of chloride of magnesium. When heated it decrepitates (more especially the coarse-grained or bay salt), at a red heat fuses, and at a still higher temperature volatilizes. Rock salt is transcalent or diathermanous: that is, it transmits radiant heat much more readily than many other transparent bodies, as glass. It is soluble in water, and slightly so in alcohol. Hot and even boiling water dissolves very little more salt than cold water. At 60° it requires about twice and a half its weight of water to dissolve it.

Characteristics.—Its characters as a soda salt are the following:—It produces no precipitate with the hydrosulphures, ferrocyanides, phosphates, or carbonates. From the salts of potash it is distinguished by causing no precipitate with perchloric or tartaric acid, or with chlorid of platinum, and by the yellow tinge which it communicates to the flame of alcohol. As a chloride it is known by nitrate of silver throwing down a white precipitate, soluble in animonia, but insoluble in nitric acid. Lastly, chloride of sodium is odourless, and devoid of bleaching properties.

Composition.—Pure chloride of sodium has the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Ure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>1</td>
<td>24</td>
<td>40</td>
<td>39·98</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1</td>
<td>36</td>
<td>60</td>
<td>60·02</td>
</tr>
<tr>
<td>Chloride of Sodium</td>
<td>1</td>
<td>60</td>
<td>100</td>
<td>100·00</td>
</tr>
</tbody>
</table>

The crystals contain no water in chemical combination with them, but little is frequently mechanically lodged between their plates.

Impurities.—The commercial salt of this country is sufficiently pure for all dietetical and therapeutical purposes; and its low price is sufficient guarantee against its adulteration. In France, however, serious accidents have happened in consequence of the use of sophisticated salt (Christison's Treatise on Poisons, 3d ed. p. 604, and Devergie, Méd. Lég. t. ii, p. 876.)

Physiological Effects. (a.) On vegetables.—In minute quantities chloride of sodium is injurious to very few, if any, plants, and to some it appears to be beneficial. Used moderately it is a most excellent manure to certain soils. In large quantities it is injurious, though unequally so to all plants. (Davy, Agricult. Chem., and Decandolle, Phys. Vég. pp. 126 and 1343.)

(b.) On animals. To marine animals common salt is a necessary constituent of their drink. It is relished by most land animals. "The eagerness with which many quadrupeds and birds press towards salt springs and lakes, situated in inland districts, for the purpose of tasting their contents, indicates," says Dr. Fleming, (Philosophy of Zoology, vol. 1, p. 316) "a constitutional fondness for salt." In the Ruminantia the salutary effects of salt are especially observed. "They contribute power
Chloride of Sodium

..." observes Moiroud (Pharmac. Vétérin. p. 410), "to prevent, in these animals, the influence of rainy seasons and wet pasturage, as well as of damaged fodder. Given to animals intended for fattening, it has more consistence to the fat and more taste to the meat." It appears offensive and injurious to many of the lower animals: hence when rubbed on meat, it prevents the attack of insects, and when applied to the lin of leeches causes vomiting.

(c.) On man.—Chloride of sodium serves some important and essential uses in the animal economy. It is employed, on account of its agreeable taste, by the people of all nations, from the most refined to the most barbarous; but the quantity taken varies with different individuals, inasmuch as some have a much greater relish for it than others. It is, I think, not probable, that this unequal appetite for salt, in different individuals, is indicative of different wants of the system for this necessary substance;—salt must serve some more important function than that of merely grating the palate. It is an invariable constituent of the healthy blood. Dr. Ewens (On the Blood) has shown that the red colour of the blood depends on the saline matters contained in it, for without these this fluid is black. Some of the properties of the sanguineous fluid, such as its acidity, its stimulating qualities, and its power of self-preservation, are probably more or less connected with its saline constituents. The free hydrochloric acid found in the stomach, and which is so necessary to digestion, is probably derived from the salt taken in with the food, and is also perhaps the soda of the blood. The chloride of sodium found in some of the secretions, as the bile and tears, probably serves some important purposes.

It is said that persons who take little or no salt with their food are very subject to intestinal worms. Dr. Paris (Pharmacologia) tells us that Lord Somerville, in his address to the Board of Agriculture, states that the ancient laws of Holland "ordained men to be kept on bread alone unmixed with salt, as the severest punishment that could be inflicted upon them in their moist climate; the effect was horrible: these wretched criminals are said to have been devoured by worms engendered in their own stomachs." Mr. Marshall (Med. and Phys. Jour. vol. xxxix.) tells us of a lady who had a natural aversion to salt: she was most dreadfully affected with worms during the whole of her life.

Considered in a therapeutical point of view it is an irritant in its local operation. Thus applied to the skin and the mucous membranes it causes redness. Taken into the stomach in large quantity (as in the dose of a table-spoonful or more) it excites vomiting, and when thrown into the large intestines produces purging. In moderate quantities it promotes the appetite, and assists digestion and assimilation. If used too freely it occasions thirst. The long-continued employment of salted provisions occasions scurvy: of the correctness of this statement there cannot exist, think, a shadow of doubt, notwithstanding the bold denial given to it by Dr. Stevens (op. cit. p. 262); a denial the more remarkable, since Dr. Ewens admits he has never seen a single case of the disease! His opinion is evidently founded on hypothetical grounds, and is in direct opposition to the best medical testimony we possess.

In some diseases the moderate use of salt produces the effects of a tonic. It acts as a stimulant to the mucous membranes, the absorbent vessels,
and glands. Occasionally it seems to merit the designation of an alternative or resolvent.

Properly diluted and injected into the veins, in cholera, it acts as a powerful stimulant and restorative; the pulse, which was before imperceptible, usually becomes almost immediately restored, and, in some cases, reaction and recovery follow. A solution of common salt produces no change in the size and form of the sanguineous particles out of the body (Müller's Physiology). Dr. Macleod injected a solution of common salt into the jugular vein of a rabbit which had been asphyxied, but without restoring or producing resuscitation (Med. Gaz. vol. ix. p. 358).

Uses.—The following are some of the most important therapeutic uses of chloride of sodium.

As a vomit, it has been recommended in malignant cholera, in preference to other emetics (Searle, Med. Gaz. vol. viii. p. 538; Sir D. Barry, Med. Gaz. vol. ix. pp. 321 and 407; Brailoff and Isenbeck, ibid, p. 490). In narcotic poisoning, in the absence of the stomach-pump and the ordinary emetic substances, it may also be employed. The dose of it is one or two table-spoonfuls in a tumblerful of water. A tea-spoonful of flour of mustard assists its action. As a purgative it is seldom employed except in the form of enema. One or two table-spoonfuls of common salt dissolved in a pint of gruel form a very useful clyster for promoting evacuations from the bowels.

It has been used in some diseases with the view of restoring the saline qualities of the blood. Dr. Stevens (op. cit.) has shewn that the red colour of the blood depends on the presence of its saline constituents and that when deprived of these, this fluid is black. Now, in cholera, the blood is remarkably black, incapable of coagulating, and contains more albumen and hematosine, but less water and saline parts, than natural; while the enormous discharges from the bowels consist of a weak solution of albumen containing the salts of the blood (Dr. O'Shaughnessy, Report on the Chemical Pathology of the Malignant Cholera, 1832). The obvious indications, therefore, in the treatment of this disease, are to restore the water and saline matters to the blood. Hence originated what has been called the saline treatment of cholera. This, at first, consisted in the exhibition of certain alkaline salts by the mouth, and in the form of enemata. The following are formulæ which have been recommended:—

Take of Carbonate of Soda . . . . half a drachm.
Chloride of Sodium . . . . a scruple.
Chlorate of Potash . . . . 7 grains.
Dissolve in half a tumblerful of water. This to be repeated at intervals of from 15 minutes to an hour, according to circumstances (Dr. Stevens, op. cit. p. 459).

Take of Phosphate Soda . . . . . . . 10 grains.
Chloride of Sodium . . . . 10 grains.
Carbonate of Soda . . . . 5 grains.
Sulphate of Soda . . . . 10 grains.
Dissolve in six ounces of water. The mixture to be repeated every second hour (Dr. O'Shaughnessy, op. cit. p. 54).

This plan, however, was followed by that of injecting saline solutions into the veins: which was, I believe, first practised by Dr. Latta (Med. Gaz. vol. x. p. 257.) The quantity of saline solution which has been in some cases injected is enormous, and almost incredible. In one case 120 ounces were injected at once, and repeated to the amount of 380 ounces in 12 hours. In another, 376 ounces were thrown into the veins between Sunday at 11 o'clock A.M. and Tuesday at 4 p. m.; that is, in the course of 53 hours, upwards of 31 pounds. The solution that was used
assisted of two drachms of muriate and two scruples of carbonate of a to sixty ounces of water. It was at the temperature of 108° F. or 9° F. (Med. Gaz. vol. x. p. 257.) In another series of cases 40 lbs were injected in 20 hours; 132 ounces in the first 2 hours; 8 lbs. in half hour! (Med. Gaz. vol. x. pp. 379-80.) The immediate effects of these injections, in a large majority of cases, were most astonishing: elevation of pulse, improvement in the respiration, voice, and general clearness, return of consciousness, and a feeling of comfort. In many instances, however, these effects were only temporary, and were followed collapse and death. In some, injurious consequences resulted, as ebolitis (Med. Gaz. vol. x. p. 453), drowsiness, (ibid. p. 447), &c. The arts as to the ultimate benefit of the saline treatment in cholera are so enigmatical, that it is exceedingly difficult to offer the student a correct impartial estimate of its value. That it failed in a large proportion cases, after an extensive trial, and greatly disappointed some of its staunchest supporters, cannot be doubted: (Med. Gaz. vol. x. p. 717.) Griffin (Recollections of Cholera, in Med. Gaz. vol. xxii. p. 319) states all the published cases of injection which he can find recorded amount to 282, of which 221 died, while 61 only recovered: but he feels that the average recoveries from collapse by this method of treatment "far exceeded the amount of any other treatment in the same disease and under the same circumstances."

Common salt has been employed as an antihelmintic. For this purpose it is exhibited in large doses by the mouth, or, when the worms are lodged in the rectum, a strong solution is administered in the form of an enema. When leeches have crept into the rectum, or have been accidentally swallowed, a solution of salt should be immediately used. As a specific antidote chloride of sodium may be administered in poisoning with nitrate of silver. As an alterative and tonic it is useful in scrofula glandular diseases. As an astringent in haemorrhages, dysentery, diarrhoea, it has been administered in combination with lime juice as lemon juice (Memoir of the late Dr. Wright, p. 322).

As an external application salt has been used for various purposes. A saturated solution of salt, applied with friction, is employed, as a counter-irritant and discutient, in glandular enlargements and chronic cases of the joint; as a stimulant, it is rubbed on to the chest in asphyxia. A solution of salt is employed for baths (cold warm), affusion, the douche, &c. Its action is more stimulating and powerful than simple water, and the reaction or glow more rapidly and certainly takes place. Consequently, the salt-water bath may be used for a longer period, without causing exhaustion, than the pure water bath. It is popular opinion, which is probably well founded, that patients are best likely to take cold after the salt-water bath than after the common water bath.

Administration.—As a tonic and alterative, the dose of salt is from one grain to a drachm. As an emetic, from two to three table-spoonfuls in the first hour. As a cathartic, from half an ounce to an ounce. In the form of oyster, it is used to the extent of two or three table-spoonfuls. A solution of one part of salt in forty parts of water will form a bath of about the same strength as sea water.
So'da Hypochlo'ris.—Hypochlor'ite of So'da.

History.—The disinfecting power of a solution of this substance was discovered by Labarraque about 1820 (Alcock, Essay on the Use of it Chlorurets, p. vi). In the London Pharmacopœia this solution is called liquor sodae chlorinata; in the French Codex, hypochloris sodicus aqua solutus. It is commonly known in the shops under the name of chlor of soda, liqueur de Labarraque, or Labarraque's soda disinfecting liquor. Other synonyms for it are chloruret of the oxide of sodium, and oxym riate of soda.

Preparation.—There are two methods in use for preparing a solution of hypochlorite of soda.

(a.) Process of the Pharmacopoeia.—Dissolve a pound of carbonate soda in two pints of water; then put four ounces of chloride of sodium and three ounces of binoxide of manganese, rubbed to powder, into a retort; and add to them four ounces of sulphuric acid previously mixed with three fluidounces of water, and cooled. Heat the mixture, and pass the chlorine, first through five fluidounces of water, and afterward through the above prescribed solution of carbonate of soda.

When chlorine gas comes in contact with a solution of carbonate of soda, three salts are formed: chloride of sodium, hypochlorite of soda, and bicarbonate of soda.

\[
\begin{align*}
\text{REAGENTS.} & \quad \text{PRODUCTS.} \\
2 \text{eq. Carbonate Soda} & \quad 2 \text{eq. Bicarbonate Soda} \\
2 \text{eq. Carb} & \quad \left\{ \begin{array}{l} 
2 \text{eq. Chlorate} \\
1 \text{eq. Sodium} \\
1 \text{eq. Oxygen} \\
1 \text{eq. Soda} \\
\end{array} \right\} \\
1 \text{eq. Chlorine} & \quad 1 \text{eq. Chloric Chlorate} \\
1 \text{eq. Chlorine} & \quad 1 \text{eq. Chloric Chlorate} \\
108 & \quad 44 \\
32 & \quad 24 \\
8 & \quad 1 \text{eq. Hypochlorite Soda} \\
72 & \quad 36 \\
\end{align*}
\]

The essential and characteristic properties of this solution depend the hypochlorite of soda. The changes which take place in the manufacture of chlorine have been already explained (p. 105).

(b.) Process of the French Codex.—Diffuse one part of dry chloride of lime (hypochlorite of lime) through 30 parts of water. Then add to parts of crystallized carbonate of soda, previously dissolved in 15 parts of water. Filter the mixture. In this process a double decomposition is effected; hypochlorite of soda is formed in solution, while carbonate of lime precipitates. This process is more easy of execution than the previous one. By using the proportions here directed the solution much weaker than that prepared by the process of the London Pharmacopoeia.

Properties.—The solution of hypochlorite of soda (liquor soda chlorinata of the London Pharmacopœia) has a yellowish colour, astringent taste, and an odour of chlorine. It destroys the colour of vegetable substances; as litmus, turmeric, and sulphate of indigo. Previous to bleaching them, it reacts as an alkali on turmeric paper, a infusion of red cabbage. By evaporation, crystals are obtained, which re-solution in water re-produce the disinfecting liquid. By exposure to the air, the solution undergoes decomposition, and the crystals of carbon of soda are formed.
HYPOCHLORITE OF SODA.

Characteristics.—The following are the essential characters of the \textit{liquor sodae chlorinate}, Ph. L.:—It decolorizes sulphate of indigo. On addition of hydrochloric acid it evolves chlorine and carbonic acid. Solution of nitrate of silver throws down a white precipitate (chloride silver) soluble in ammonia, but insoluble in nitric acid. Lime water gives a white precipitate (carbonate of lime). Oxalate of ammonia asions no precipitate, shewing the absence of lime. Chloride of tinum produces no yellow precipitate, proving the absence of potash ammonia. That the base of the solution is soda may be shewn in three ways: evaporated to dryness, we obtain a residuum which renders outer cone of the flame of a candle, or the flame of a spirit lamp, low: saturated with hydrochloric acid and evaporated to dryness, ammonia is procured: this may be recognized by the characters before mentioned (p. 310).

Composition.—Some chemists regard the \textit{liquor sodae chlorinate}, Ph. L. a mixture of chloride of soda and bicarbonate of soda. But the view of this is that it consists of hypochlorite of soda, chloride of lithium, and bicarbonate of soda.

Physiological Effects. (a.) \textit{On animals}.—A solution of chloride of soda acts as a local irritant, more or less powerfully according to the state of its concentration. From the experiments of Segalas (\textit{Journ. Chim. Med.} t. 1er. p. 271) it appears that besides the irritant operation, its direct and sympathetic action on the organic solids, it exercises evident influence over the blood, and, in consequence, over the whole animal, by means of absorption. In an experiment referred to by Dr. Christison, (\textit{Treatise on Poisons}, 3d ed. p. 221) two ounces of Labarthe's solution introduced into the peritoneum of a dog excited palpitatiou, oppressed breathing, constant restlessness, and death in ten minutes.

(b.) \textit{On man}.—I am unacquainted with any experiments made to determine the physiological effects of chloride of soda on man. That it acts as a local irritant, and, if swallowed, rise to symptoms of gastro-enteritis, cannot, I think, be doubted. Rat and de Lens (\textit{Dict. Mat. Méd.} t. ii. p. 257) state that the immediate consequence of, and predominating symptoms produced by, a glass of \textit{eau de javelle} (a solution of chloride of potash) was general rigidity, which gave way to demulcent drinks. This observation agrees with one by Segalas (Christison, \textit{op. cit.} p. 221) in his experiments on dogs, who, after chloride of soda caused tetanic spasms. It is probable, therefore, that the chlorides (hypochlorites) of the alkalies exercise a specific influence over the nervous system.

Chloride of soda, in moderate or small doses, has been denominated ulcerant, tonic, astringent, antiseptic, and febrifuge. But these terms, no real explanation of the nature of these organic changes produced by the remedial agent, whereby we obtain such benefit from its employment in various diseases. In fever I have seen dampness of the skin and its use. Increased secretion of urine is a common effect of it. In fevers it improves the qualities of the evacuations. Under the continued employment of it, glandular enlargements and chronic mucous ulcers have disappeared, from which circumstance chloride of soda has been denominated alterative and resolvent. All these effects dependably on the alteration which the chloride gives rise to in the condition of the blood, and the change thereby produced in the action of the
different organs. We must not overlook the important fact that the solution of chloride of soda used in medicine contains bicarbonate of soda, to which perhaps in many cases its beneficial effects are, in part, at least, to be referred.

Uses.—The solution of chloride of soda is employed as a disinfectant, antiseptic, and antidote (in cases of poisoning by the hydrosulphuretted and hydrosulphuric and hydrocyanic acids.) But for most of the purposes the chloride of lime is employed instead of chloride of soda, since its properties are analogous, and being manufactured on a very extensive scale for the use of bleachers, it can be obtained more conveniently and cheaply. On this account, therefore, and to avoid repetition, I must refer to the article Hypochlorite of Lime for information respecting the above uses of chloride (hypochlorite) of soda. I won’t remark, however, that in several cases where I have carefully tried and compared the two chlorides (hypochlorites) I give the decided preference to the chloride of soda. As an antiseptic, Labarraque also preferred the latter preparation, on the ground that by the process of disinfection becomes chloride of sodium, which is not a deliquescent salt; whereas the chloride of calcium generated by chloride (hypochlorite) of lime attracts water from the atmosphere, and thereby furnishes one of the conditions (viz. moisture) necessary to the putrefactive process. Hence, in his opinion, while chloride of lime will serve equally well for local disinfection, chloride of soda is preferable where we wish at the same time to prevent a renewal of putrefaction.

Chloride of soda is employed internally in all diseases common to cases of putrid or malignant, as typhus fever, scarlatina maligna, &c. is indicated where there are great prostration of strength, fetid evacuations, and a dry and furrowed tongue. In such cases I have seen it essential service, improving the quality of the secretions, producing a moist state of the skin, preventing collapse, and altogether acting more beneficially. It may be administered both by the mouth and the rectum.

There are many other diseases in which the solution of chloride of soda has been administered internally with apparent success; but which a more extended experience of its effects is required to enable us to place confidence in the results. I refer now to the employment of a substance as a substitute for the disulphate of quinia, in intermittent fever, recommended by Lalesque and Gouzée (Brit. and For. Med. Rev. April 1838); to its use in the treatment of secondary syphilis, as practised by Dr. Scott (Lon. Med. Rep. N. S. vol. ii. 1826, p. 139), and by Cazeno (Journ. de Chim. Méd. t. iv. p. 140); to its administration in chronic skin diseases, and as a substitute for chlorine in bilious disorders by Darling (Lon. Med. Rep. N. S. vol. ii.); in scrofula, by Godier (Jou. Gén. de Méd. 1829); and in plague, by Neljoubin (Richter, ausf. Al. neim. Suppl.-Bd. p. 539.) In some of these cases (as in syphilis or scrofula) the benefit obtained may have resulted from the bicarbonate of soda present in the chloride of the shops.

As a local remedy, we employ chloride of soda in all cases attended with fetid discharges, not merely as a disinfectant and antiseptic, but as a chemical agent destroying fetor, and preventing the putrefaction of dead matters (as gangrenous parts, the discharges from wounds and ulcers, &c.) though in these respects it is most valuable—but as a med...
stopping or relieving morbid action by an impression produced on the
living tissues. It frequently puts a stop to the further progress of gan-
one; promotes the separation of the dead from the living parts; 
proves the quality of the secretions; and, at the same time, diminishes 
their quantity, when this is excessive. We apply it to ulcers of all kinds 
(whether common, phagedenic, cancerous, syphilitic, or scrofulous) 
then attended with foul discharges or a disposition to slough. We 
apply it with the greatest benefit in affections of the mucous surfaces.
As it is used as a gargle to check ptyalism and ulceration of the 
throat, whether arising from mercury or other causes. In scarlatina 
(whi we apply it to check ulceration and sloughing of the throat. In 
syzya and ozaena it has been injected into the nostrils with considerable 
benefit. In fetid and excessive discharges from the vagina, and neck of 
the uterus or bladder, it is employed as an injection with, at least, tem-
orary relief. It has also been applied in some skin diseases, as tinea 
bariliis, eczema, scabies, prurigo pudendi muliebris, &c. The above are 
only a few of the cases in which chloride of soda has been used with 
most marked benefit. In conclusion, I may justly add, that there are 
many, if any, remedies the uses of which, as local agents, are so valuable 
and extensive, as the chlorides of soda and lime.

ADMINISTRATION.—The liquor sodeae chlorinatae, Ph. L. may be ad-
mnistered internally in doses of twenty drops or more, diluted with three or 
four ounces of some mild aqueous liquid. When used as a gargle, it 
could be diluted with eight or ten parts of water: as an injection into 
the vagina, it is to be mixed with from fifteen to thirty parts of water: 
as a wash, its strength must vary according to circumstances. In some 
denting ulcers I have used it mixed with its own volume of water, and 
in most cases it should, at the commencement of its use, be largely 
undiluted.

ANTIDOTE.—(See Calcis Hypochloris.)

Sodae Sulphas.—Sulphate of Soda.

HISTORY.—Sulphate of soda (also called natron vitriolatum, Glauber's 
Salt, sal catharticus Glauberi, or sal mirabile Glauberi) was discovered in 
1558 by Glauber.

NATURAL HISTORY.—It occurs in both kingdoms of nature. As a 
lorescence, the hydrous sulphate of soda is met with in various parts 
of the world. In the anhydrous state, mixed with a minute portion of 
hydrate of soda, it constitutes the mineral called Thenardite. Sul-
phate of soda is a constituent of many mineral waters; as those of 
Blenheim, Leamington, and Spital. It is found in the ashes of some 
plants which grow by the sea-shore; as the Tamarix gallica. Lastly, it 
found in some of the animal fluids; as the blood and urine.

PREPARATION.—It is a product of several chemical processes. In the 
pharmacopeia it is directed to be prepared from the salt which remains 
over the distillation of hydrochloric acid. This salt consists of sulphate 
with some bisulphate of soda. It is to be dissolved in water, and to the 
fusion carbonate of soda is to be added, to saturate the excess of acid 
the bisulphate. The liquid is then to be boiled down, strained, and 
stallized.
In consequence of the enormous consumption of sulphate of soda in the manufacture of carbonate of soda, makers of the latter article are obliged to procure sulphate purposely, by the addition of sulphuric acid to chloride of sodium.—[For the theory of this process, see p. 149.]

Properties.—The primitive form of the ordinary crystallized sulphate of soda is the oblique rhomboic prism. To the taste this salt is cooling and bitterish saline. By exposure to the air it effloresces. When heated it undergoes the watery fusion, gives out its water of crystallization, and thereby becomes a white solid, and at a red heat it again becomes liquid. One part of it dissolves in three parts of water at 60°, or one part of water at 212°. It is insoluble in alcohol.

Characteristics.—Its constituents, sulphuric acid and soda, may be detected by the tests for these substances before mentioned (pp. 265 and 310). From the bisulphate of soda it is distinguished by its not reddening litmus, and by its less solubility. Crystals of anhydrous sulphates of soda are distinguished by their form being the rhombic octahedron.

Composition.—The ordinary crystals of sulphate of soda have the following composition:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Berzelius.</th>
<th>Wenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soda</td>
<td>1</td>
<td>32</td>
<td>19:75</td>
<td>19:24</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>24:69</td>
<td>24:76</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>90</td>
<td>55:56</td>
<td>56:00</td>
</tr>
</tbody>
</table>

Purity.—The crystallized sulphate of soda of the shops is usually sufficiently pure for medical purposes. The presence of chlorides in it may be detected by nitrate of silver.

Physiological Effects.—It is a mild but efficient cooling laxative or purgative salt, promoting secretion and exhalation from the mucous membrane of the stomach and bowels, without causing inflammation of fever.

Uses.—It may be employed as a common purgative, either alone or added to other purgatives. It is applicable in fevers and inflammatory affections, where we want to evacuate the bowels without increasing or causing febrile disorder.

Administration.—The usual dose of it is from six to eight drachms. When dried, so as to expel the water of crystallization, three and a half drachms act as an efficient purgative.

So'dæ Bibó'ras.—Bibo'rate of So'da.

History.—Pliny (Hist. Nat. lib. xxxiii) describes a substance under the name of chrysocolla, which has been supposed by some to be biborate of soda. The term bauracon or baurach (from which our word borax is derived) first occurs in the writings of the Arabians. By some of these authors (as Mesue and Avicenna) it was applied to nitre (Beckmann, Hist. of Invent. and Discov. vol. iv. p. 559): it is not improbable, however, that Geber (Search of Perfection, ch. iii.) used it to indicate our borax. By modern chemists the salt has been termed biborate, borate, or sub-borate of soda.
NATURAL HISTORY.—Borax is a substance peculiar to the mineral world. It has been found in some mineral waters; as those of San Quintin, in Ischia (Gairdner, On Mineral Springs, p. 414). It occurs in the waters of certain lakes, especially those of Thibet and Persia.

PREPARATION.—Borax is obtained in two ways:—1st, by refining the borax; 2dly, by saturating native boracic acid with soda.

a.) By refining native or crude borax.—About fifteen days' journey th from Teecshoo Lombo, in Thibet, is a lake, said to be about sixty miles in circumference, and supplied by brackish springs rising in the bottom of the lake itself. In consequence of its high situation, during a part of the year this lake is frozen over. The water of it consists, in solution, both common salt and borax. The latter crystallizes the edges and shallows of the lake, and is taken up in large masses, which are broken and dried.

It is imported, usually from Calcutta, under the name of tincal (a word derived from tincana, the Sanscrit name for borax; Royle's Essay (Hindoo Medicine, p. 97) or crude borax (borax cruda seu nativa), the form of flattened six-sided prisms, coloured with a greasy unctuous substance, said, by Vauquelin, to be a fatty matter, saponified by soda; colour is yellowish, bluish, or greenish. Mojon states that the liquid grey matter which surrounds some kinds of rough borax, consists native boron. Various methods have been contrived for refining it; some calcine it, to destroy the fatty matter, others wash it with an alkaline solution (soda or lime), and then dissolve and crystallize. The product is called refined borax (borax depurata seu purificata).

b.) By saturating native boracic acid.—In the year 1776, Messrs. Derfer and Mascagni discovered boracic acid in the Lagoni of Tuscany, a state of efflorescence, and also in solution in the waters with which the soil is impregnated. From the soil is constantly evolved aqueous four, impregnated with boracic and hydrosulphuric acids; formed, as is supposed, by the action of water on sulphuret of boron contained the interior of the earth,—by which part of the water is decomposed, oxygen of which acidifies the boron, while the hydrogen forms sulphuric acid with the sulphur, and the heat evolved causes the evaporation of some aqueous vapour. By washing the mud surrounding fumaroles, or craters, decanting the liquor, and evaporating, rough Tuscany boracic acid is obtained. To form borax from this, a solution the carbonate of soda is saturated with the rough acid: efflorescence of place, and borax is formed.

PROPERTIES.—It occurs in large, colourless, transparent crystals, whose primary form is the oblique rhombic prism. In commerce we usually meet with it in irregular shaped masses. Its taste is saline, pungent, and somewhat alkaline. It reacts on turmeric paper like an alkali. By exposure to the air it effloresces slowly and slightly. When it melts in its water of crystallization, swells up, and forms a white, porous substance, called calcined borax (borax usita seu calcinata). At a higher temperature it fuses into a transparent glass (mass of borax), which is anhydrous borax. It is soluble in twelve parts of cold, or in two parts of hot water.

CHARACTERISTICS.—Borax may be recognized by the following characters: it reddens turmeric paper; it fuses before the blowpipe into a
glass, which may be readily tinged by various metallic solutions,—the rose red by chloride of gold, and blue by solutions of cobalt; if a few drops of sulphuric acid be added to powdered borax, and then spirit wine, the latter will, when fired, burn with a green-coloured flame; lastly, if to a strong hot solution of borax, sulphuric acid be added, boracic acid will be deposited in crystals, as the liquid cools. The test now mentioned for the most part only prove the salt to be a borate: the nature of the base is determinable by the tests for soda before described (p. 310).

COMPOSITION.—Chemists are not agreed as to the precise atomic constitution of borax, in consequence of a difference of opinion as to the equivalent of boron. In the following table the first column shows the number of equivalents according to Berzelius, Dumas, and Turner,—the second, according to L. Gmelin, Brande, and Phillips.

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Berzelius</th>
<th>L. Gmelin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soda</td>
<td>1</td>
<td>1</td>
<td>32</td>
<td>16·666</td>
<td>16·31</td>
</tr>
<tr>
<td>Boracic Acid</td>
<td>2</td>
<td>1</td>
<td>70</td>
<td>36·458</td>
<td>36·59</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>10</td>
<td>90</td>
<td>46·875</td>
<td>47·10</td>
</tr>
<tr>
<td>Crystallized Borax</td>
<td>1</td>
<td>1</td>
<td>192</td>
<td>99·999</td>
<td>100·00</td>
</tr>
</tbody>
</table>

By a particular management of the crystallizing process, Payen has obtained borax in permanent octahedral crystals, containing only five equivalents of water. It is termed octahedral borax, in contra-distinction to the ordinary kind, which is called prismatic borax. Octahedral borax offers several advantages to the arts over the prismatic variety (Guibon Hist. des Drog. t. i. p. 191, ed. 3me).

PHYSIOLOGICAL EFFECTS.—The effects of borax have been imperfectly ascertained. Its local action is that of a mild irritant: applied to skin it excites smarting, and taken into the stomach, in large doses, excites vomiting.

The constitutional effects are probably those of a mild refrigerant and diuretic. Wöhler and Stehberger detected it in the urine, so that it passes out of the system unchanged.

By some writers it is regarded as an agent exercising a special influence over the uterus; promoting menstruation, alleviating the pain which sometimes attends this process, facilitating parturition, diminishing the pain of accouchement, and favouring the expulsion of the placenta and lochia (Vogt's Pharmacodynamik). Further evidence, however, is wanting to enable us either to admit or deny the supposed uterine influence of borax. Some recent English writers seem to entertain no doubt as to its promoting uterine contractions (Dr. Copland, Brit. of Pract. Med. art. Abortion, and Brit. and For. Med. Rev. for July 183 page 86).

Borax has also been regarded as producing the effects of alkalies on the system; principally, I believe, from an erroneous notion that it was subsalt (Vogt, op. cit. and Sundelin, Heilmittellehre). When Hombro asserted that boracic acid was a sedative, borax was supposed to possess similar properties.

USES.—As a local agent, borax is employed, as a detergent, in a phthisic and ulceration of the mouth. In some skin diseases it has been us-
PHOSPHATE OF SODA. 321

th benefit: as pityriasis versicolor (called also liver spots or chloasma). The solution of it in rose-water is employed as a cosmetic. In gonorrhoea and leucorrhœa an aqueous solution has been occasionally used, as an injection, with success. Lastly, in the form of ointment it has been applied to inflamed and painful haemorrhoidal tumors.

Internally it has been used to diminish the secretion of uric acid; to act as a diuretic in dropical cases; and to influence the uterus in the cases before mentioned. To promote uterine contractions, Dr. Copland recommends it in conjunction with ergot of rye.

ADMINISTRATION.—The dose of it is from half a drachm to a drachm.

A detergent in aphtha it may be used in powder, mixed with sugar or honey. The MELLITE OF BORAX (mel boracis, Ph. L.) consists of a drachm of powdered borax mixed with an ounce of clarified honey; it is the most eligible form for the employment of borax in the aphtha of children.

So'de Phosph'phas.—Phosph'phate of So'da.

HISTORY.—This salt was long known before its true nature was understood. In 1737 Hellot found it in the urine. It has been known by various names, such as alcali minerale and sal mirabile perlatum. In the shops it is sold as tasteless purging salts. Dr. Turner calls it triphosphate of borax and basic water. It is sometimes termed the rhombic phosphate of soda.

NATURAL HISTORY.—It has been found, in small quantities, in several waters (Gairdner, On Mineral Springs, p. 19). It exists in many mal fluids, especially the urine of man.

PREPARATION.—It is procured as follows:—carbonate of soda is added to the impure solution of phosphoric acid, obtained by digesting bone-phosphate in sulphuric acid (vide p. 250) to saturation: the liquid is then red, evaporated, and put aside to crystallize. A slight excess of soda noting the formation of fine crystals.

PROPERTIES.—The primary form of the crystals of this salt is the opaque rhombic prism. The crystals are transparent, but by exposure the air effloresce and become opaque. Their taste is cooling saline. They react feebly on vegetable colours like alkalies. When heated, they undergo the watery fusion, give out water, and form a white mass which has been called pyrophosphate of soda: at a red heat this melts into a transparent glass, called metaphosphate of soda. The crystals of phosphate of soda require, for their solution, four times their weight of cold or twice their weight of hot water: they are nearly insoluble in alcohol.

CHARACTERISTICS.—The presence of soda in this salt is known by the fact for this base before mentioned (p. 310). The phosphoric acid in it is recognised as follows: a solution of the phosphate throws down a white precipitate with acetate of lead, as well as with chloride of barium: a precipitate in both cases is a phosphate, and dissolves in nitric acid without effervescence: with nitrate of silver, the phosphate of silver occasions a yellow precipitate soluble both in nitric acid and ammonia: pyrophosphate of soda, obtained by heating the phosphate, fuses a white precipitate with nitrate of silver: hydrosulphuric acid, well as the hydrosulphates, occasion no change in a solution of phosphate of soda. Phosphate of lead fused upon charcoal, in the outer flame of the blowpipe, becomes distinctly crystalline upon cooling.
Composition.—Some difference of opinion exists as to the atomic constitution of this salt, as is obvious from the following table:

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<tr>
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<tbody>
<tr>
<td>Soda</td>
<td>1</td>
<td>32</td>
<td>18-2</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>1</td>
<td>36</td>
<td>20-3</td>
</tr>
<tr>
<td>Water</td>
<td>14</td>
<td>108</td>
<td>61-3</td>
</tr>
</tbody>
</table>

Crystallized Phosphate Soda

According to Mr. Graham, one of the twenty-five equivalents of water performs the function of a base to the acid.

Physiological Effects.—In doses of an ounce, or an ounce and a half, it acts as a mild antiphlogistic purgative, like sulphate of soda. In small and continued doses it has been used with the view of altering the composition of the blood, and of promoting the deposit of phosphate of lime in the bones.

Uses.—As a purgative it is employed in the diseases of children and delicate persons, in preference to other saline substances, on account of its slight taste and mild action on the stomach. It is well adapted for febrile and inflammatory disorders.

It is one of the substances which have been employed in cholera, to restore to the blood its deficient saline matters (Dr. O'Shaughnessy, Report on the Chemical Pathology of the Malignant Cholera, p. 54). On account of the phosphoric acid which it contains it has been supposed to be particularly applicable in those diseases in which there is a deficiency of phosphate of lime in the bones. It has also been administered in diabetes.

Administration.—As a purgative it is given in doses of from six to twelve drachms. It is best taken in broth or soup. As an alterative the dose is one or two scruples three or four times a day.

So'dae Car'bonas.—Car'bonate of So'da.

History.—This salt, as well as the sesquicarbonate of soda, was probably known to the ancients under the term of *vir'pov*, or *nitrsum* (vi Potasses Nitris, p. 292; also Sodae Sesquicarbonas). The salt-alkali, *sagimen vitri* of Geber (Invent. of Verity, ch. iv., and Search of Perfection, ch. iii.) was a carbonate of soda: the word *sagimen* is a corruption of the Hindoo term *sajjiloon* (Dr. Royle, Essay on Hindoo Medicine p. 41). In modern times this salt has had various appellations, such as mild mineral or fossil alkali, aérated mineral alkali, subcarbonate of soda, and natrium carbonicum.

Natural History.—It is found in crystals, or in the form of an effervescent powder, in several parts of the world. According to Klaproth (quoted by Dr. Thomson, in his Outlines of Mineralogy, vol. i. p. 9) it occurs at Debrezin, in Hungary, and Montenovo, near Naples; and by Necker in his Règne Minéral, t. 2me p. 667) he analyzed three native carbonates of soda: one from Lac Blanc, in Hungary; a second from Egypt; and a third from Vesuvius. Carbonate of soda is a constituent of some mineral waters, which are, in consequence termed alkaline, or, when they also contain a large excess of carbonic acid, acidulo-alkaline (see p. 148).

Preparation.—It may be procured from barilla, from kelp, or from sulphate of soda.
From barilla.—The substance called barilla is an ash usually ained by the combustion of plants belonging to the order Chenopo- cee; as the Salsolas, Salicornias, and Chenopodiaceae. These are cul- tured on the coasts, and when ripe are cut, dried, and burned in hoppers: resulting ash is barilla. It is a hard greyish or bluish mass, not deli- scent, having an alkaline acid taste, and a peculiar odour. It con- sists of carbonate and sulphate of soda, sulphuret and chloride of sodium, carbonate of lime, alumina, silica, oxide of iron, and carbonaceous matter which has escaped combustion. The carbonate of soda is produced by decomposition of the oxalate and other organic salts of soda con- ced in the plants before combustion. Several varieties of barilla are kn in the market: they are distinguished by the names of the places whence they are imported; namely, the Grand Canary and Teneriffe nds, Alicant, Sicily, Carthagena, and the East Indics. Canary barilla procured from Salsola Kali (Loudon, Encyclop. of Agricult.); Alicant barilla (soda hispanica, s. alicantina) is obtained from Salsola sativa, npodium setigerum, and other species (Lagasca, quoted in Decane- s's Phys. Vég. p. 388). It yields from 25 to 40 per cent. of carbonate soda. Sicily barilla is procured principally from Salsola sativa: it fur- nes, according to Fée (Cours d'Hist. Nat. t. 2nd. p. 488), 55 per cent. ofenate of soda. Of the French barillas two only deserve notice; ely, that of Narbonne, obtained from Salicornia herbacea, and which is 14 or 15 per cent. of carbonate; and that of Aiguemortes, called aigrette, and which contains from 3 to 8 per cent. only of alkaline carbonate.

Carbonate of soda is procured from barilla by dissolving it in water, rking the solution, evaporating, and crystallizing. The importation of la has very much fallen off of late years, in consequence of the c tion of carbonate of soda from sulphate of soda. In 1827 the quan- imported was 326,239 cwts. (A General Statement of the Imports lports, printed by order of the House of Commons, 24th Feb. ); whereas, in 1837, it was only 16,760 cwts. (Trade List, Jan. 9,

From kelp.—Kelp (called by the French Varec or Normandy Soda) curred by the combustion of cryptogamic plants of the order Algaceae. cording to Dr. Greville (Algæ Britannica, p. xxi.) the species most ed for this purpose are Fucus vesiculosus, nodosus and serratus, Lam- digitata and bulbosa, Himanthalia lorea, and Chorda Filum. These urned in coffers of stone or in kilns. About 24 tons of sea-weed are d to produce one ton of kelp (Maculloch's Western Islands, vol. i. 3). The resulting ash is kelp. As met with in commerce, it con- of hard, dark grey or bluish masses, having an acid caustic taste, omposed of chloride of sodium, about five per cent. of carbonate of (formed by the decomposition of the oxalate and other organic salts ala), sulphates of soda and potash, chloride of potassium, iodide of sium or sodium, and insoluble and colouring matters. By diges- a small quantity of water, filtering and evaporating the solution, als of carbonate of soda may be procured. But as this salt can be red at a lower price and of finer quality from artificial soda, kelp is of little value as a source of soda. In the Orkney Islands, about 0 persons were, a few years since, occupied in the manufacture of (Greville, op. cit.)
3. From sulphate of soda.—The principal manufactories are situated in the northern parts of the kingdom, and are conducted on a most extensive scale. The process adopted varies in some of its details in different places.

The sulphate of soda employed is, in part, obtained from manufacture of chloride of lime, who procure a considerable quantity in the process for generating chlorine. But the greater part of it is made expressly by adding sulphuric acid to common salt (chloride of sodium). The hydrochloric acid which is evolved is allowed to escape into the atmosphere, and is most injurious to animal and vegetable life, as I have before stated (vide p. 150). In the report of a trial at Lancaster, March 21, 1838, the Queen v. Airey, in the Times newspaper, is contained a very humorous account of the unpleasant effects of this gas. For the sake of economy, manufacturers of carbonate of soda usually make the own sulphuric acid.

The sulphate of soda is usually decomposed by mixing it with charcoal and some carbonaceous matter (small coal, charcoal, or sawdust), and heating the mixture in a reverberatory furnace. The proportions used by Leblanc (Dumas, Traité de Chimie, t. 2me, p. 475) are 1000 parts dry sulphate of soda, 1000 of chalk, and 550 of charcoal. In a large manufactory in the neighbourhood of London the proportions of the ingredients employed are nearly 2 parts sulphate, 1 part chalk, and 1 part small coal. The product of this operation has a dark grey or black appearance, and is called English barilla or ball alkali. By lixiviating with water and evaporating the resulting solution, a blackish crystalline mass is obtained, which, when roasted, is called soda-ash. This is digested in water, the solution evaporated, and the carbonate of soda afterwards crystallized in iron pans. For other modes of proceeding I must refer to the Traité de Chimie of Dumas, or Brande’s Manual of Chemistry, and Duncan’s Edinburgh Dispensatory.

The theory of the process is the following: the sulphuric acid in the sulphate is deprived of oxygen by the carbonaceous matter (coal or sawdust), while its sulphur is partly burnt and escapes as sulphurous acid, and partly combines with the calcium of the chalk to form sulphuret of calcium. The soda unites with carbonic acid produced by the decomposition of the chalk, as well as by the combustion of carbon. To purify the impure carbonate of soda of the shops, it is ordered, in the Pharmacopoeia, to be dissolved, strained, and re-crystallized.

Properties.—Carbonate of soda usually forms large crystals, the primitive form of which is, according to Mr. Brooke, the oblique rhomb prism. They are transparent, and have a cooling alkaline taste. Exposure to the air they effloresce. When heated they undergo watery fusion and give out their water of crystallization: at a red heat, whole of the water is expelled, and when the resulting anhydrous carbonate has been rubbed to powder it constitutes the soda carbonas exsicca. Ph. L.: 54 grains of which are equivalent to 144 grains of the crystallized salt. Carbonate of soda is insoluble in alcohol. It dissolves twice its weight of water at 60°, and in less than its own weight at 212°. The solution reacts as an alkali on vegetable colours.

Characteristics.—As a carbonate it is known by the tests for this class of salts already stated (vide p. 301.) From the bicarbonates it is distinguished by the brick-red precipitate (percarbonate of mercury.}
ich it throws down with bichloride of mercury. Sulphate of magnesia uses a white precipitate with it. As a soda salt it is recognised by the tests for this basic substance already stated (p. 310.)

**COMPOSITION.**—The perfect crystals of the ordinary carbonate of soda commerce have the following composition:

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<tbody>
<tr>
<td>Soda</td>
<td>1</td>
<td>32</td>
<td>22:25</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>1</td>
<td>22</td>
<td>15:25</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>90</td>
<td>62:5</td>
</tr>
<tr>
<td>Crystallized Carbonate of Soda</td>
<td>1</td>
<td>144</td>
<td>100:00</td>
</tr>
</tbody>
</table>

**IMPURITY.**—The ordinary impurities of this salt are sulphates and chlorides. These are detected as follows:—Supersaturate with nitric acid, and then add, to separate portions of the solution, chloride of barium and bichloride of silver: if the first occasion a white precipitate, it indicates the presence of a sulphate—if the second also produce a white precipitate, soluble in ammonia, it shows the presence of a chloride.

**PHYSIOLOGICAL EFFECTS.**—Carbonate of soda is less acrid, and has a weaker and less unpleasant taste, than carbonate of potash; but in other respects the effects of these two salts on both vegetables and animals are the same.

**USES.**—Carbonate of soda is used in the same cases as carbonate of ash, over which it has the advantage of a less disagreeable taste. Barcroft imagined that as soda is contained in animals in larger proportions than potash it was a better agent for medicinal use. Experience, however, has not confirmed this opinion, but has proved the reverse; for Sir G. Blane (Trans. of a Society for the improvement of Med. and Surgery. Knowledge, iii. 347) and Mr. Brande (Quart. Journ. of Science, ii. vi. p. 205) state that they obtained beneficial effects, in calculous complaints, from the use of potash, where soda failed to give any relief. G. Blane accounted for this by assuming that soda becomes applied the purposes of the economy before it reaches the kidneys, whereas ash is carried to these organs in order to be thrown out of the system.

**ADMINISTRATION.**—Crystallized carbonate of soda is exhibited in doses from ten grains to half a drachm or a drachm, or five grains to a scrope of the dried carbonate, which may be given either in the form of powder or pills.

It is sometimes employed in the manufacture of the effervescing ought. A scrupule of the crystallized salt saturates about 9½ grains of the ordinary crystals of citric acid, 10½ grains of crystallized tartaric acid, or 2½ fluidrachms of lemon juice.

**ANTIDOTES.**—(Vide art. Potassa, p. 279).

So'dae Sesquicarbon'bonas.—Sesquicarbon'bonate of So'da.

In the province of Sukena, near Tripoli, is found a substance which the Italians call Trona—a word from which are probably derived the terms bor, nitrum, and natron (vide Potassae Nitras and Soda Carbonas). From the analyses of Klaproth (Beiträge, iii. 83), Phillips (Quart. Journ. Science, vol. vii. 297), and Beudant (quoted by Necker, Règne Minéral,
ii. 668) show that the quantity of carbonic acid which it contains is larger than the carbonate, and less than the bicarbonate: hence Mr. Phillips denominated the salt a sesquicarbonate. From the analysis of MM. Mariano de Rivero and Bossingault (Ann. de Chim. xxix. 110) it appears that the substance termed Urao, and which occurs at the bottom of a lake at Lagunillas, near Merida, in South America, has a similar composition.—[For an account of this lake, see Quart. Journ. of Science vol. i. p. 188.]

The white powder sold in the shops of this country for making soda powders, and which is denominated carbonate, bicarbonate, or sesquicarbonate of soda, is a compound of soda and carbonic acid; the quantity of the latter constituent being greater than that of the carbonate, but less than that of the bicarbonate. Hence in the Pharmacopoeia this salt is denominated soda sesquicarbonas, and its composition has been supposed to be identical with the trona of Africa and the urao of South America. It is distinguished from the ordinary carbonate of soda by its not causing a white precipitate with a cold solution of sulphate of magnesia.

The so-called sesquicarbonate of soda of the shops, usually, if not invariably, contains carbonate and bicarbonate of soda; these may be detected as follows:—Wash with a small quantity of distilled water, and filter: the solution contains carbonate of soda (known by its throwing down a brick-dust red precipitate on the addition of bichloride of mercury)—while there remains on the filter bicarbonate of soda (recognized by its causing a white precipitate, or a slight milkiness or opalescence with bichloride of mercury).* The relative proportions of carbonate and bicarbonate of soda are not constant—a fact which will explain the following remark made by Mr. Phillips (Transl. of the Pharm. 3rd ed 1838):—"I am informed by Mr. Everitt that bicarbonate of soda is now not unfrequently to be met with; and very commonly, instead of mere sesquicarbonate, a mixture of this salt and a large proportion of bicarbonate may be obtained from those who manufacture on a large scale. (For further information respecting the soda sesquicarbonas, Ph. L., see Sode Bicarbonas.)

The composition of native crystallized sesquicarbonate of soda is as follows:

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<tbody>
<tr>
<td>Soda</td>
<td></td>
<td>1</td>
<td>32</td>
<td>38·55</td>
<td>37·0</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>½</td>
<td>33</td>
<td>39·76</td>
<td>38·0</td>
<td>40·13</td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>18</td>
<td>21·69</td>
<td>22·5</td>
<td>21·24</td>
</tr>
<tr>
<td>Sulphate Soda</td>
<td></td>
<td></td>
<td></td>
<td>2·5</td>
<td></td>
</tr>
<tr>
<td>Native Sesquicarbonate Soda 1</td>
<td></td>
<td>83</td>
<td>100·00</td>
<td>100·0</td>
<td>99·99</td>
</tr>
</tbody>
</table>

* I have been recently informed by Mr. Scanlan that the salt called Ammonia Sesquicarbonas (vide p. 173) is resolved, by washing with water, into two salts, the carbonate of ammonia, which dissolves, and a mass of crystals of bicarbonate of ammonia having the form of the lump of sesquicarbonate employed. Mr. Scanlan has obligingly furnished me with illustrative specimens of the above results. The crystals of what he has sent me as bicarbonate of ammonia have, however, a slight odour of ammonia; but he tells me, that when first prepared they were odourless. Dr. Dalton (Mem. of the Lit. & Phil. Soc. of Manchester, 2nd Ser. vol. iii. p. 18) seems to have been aware that the salt now called sesquicarbonate of ammonia was a mixture of two salts.
So'dae Bi-car'bonas.—Bi-car'bonate of So'da.

History.—This salt was discovered by Valentine Rose. In some orks it is termed *natron carbonicum perfecte saturatum seu acidulum.* Dixed or combined with carbonate of soda it constitutes the *soda sesquicarbonas* of the Pharmacopœia—the carbonate or bicarbonate of soda or shops.

Natural History.—It is a constituent of the mineral waters called *idulo-alkaline,* as those of Carlsbad and Seltzer.

Preparation.—There are several methods of procuring it. Of these I will briefly notice three.

1. Process of the Pharmacopœia.—The substance called in the London Pharmacopœia *soda sesquicarbonas* is ordered to be prepared as follows:—

   Dissolve seven pounds of carbonate of soda in a gallon of distilled water, and strain; then pass carbonic acid into the solution to saturate, that the salt may subside. Dry this with a gentle heat, wrapped and pressed in cloth. According to Mr. Brande (Manual of Chem.) 50 lbs. of carbonate should be dissolved in 13 gallons of water, and carbonic acid thrown into the solution in a proper apparatus. About 50 lbs. of bicarbonate fall: and when separated should be dried in an auralic press, and afterwards by exposure to heat not exceeding 100° F., a fresh portion of carbonate is dissolved in the mother liquor, and the operation repeated as before.

   The carbonic acid used in this process is usually procured artificially, the action of dilute sulphuric acid on carbonate of lime. In some countries, however, it is obtained from natural sources, as at Vichy, where it is collected from the mineral waters. (For a description and sketch of the apparatus used in the collection of the gas by D'Arcet, see De l'Indust. 3me. t. p. 61.)

2. Smith's process.—This consists in placing the ordinary carbonate of soda in a box, and surrounding it by an atmosphere of carbonic acid under pressure. As the bicarbonate combines with much less water than carbonic acid than is contained in the carbonate, a considerable portion of water is liberated, which, saturated with part of the salt, is allowed to drain off: when the gas ceases to be absorbed, the salt is taken out and dried. On examination it is found to have retained the original form of the pieces; but they have become of a porous and loose texture, presenting the appearance of numerous crystalline grains, aggregated together, and having a snow-white colour. (Journ. of the Philadelphia Colle of Pharm. vol. i. quoted by Dr. Bache in the United States Dispensatory. For a sketch of the apparatus employed by Souberain in performing Smith's process, see his Nouv. Traité de Pharm. 1. 2me. p. 341.)

3. Process by sesquicarbonate of ammonia.—This is the process adopted to be followed in the London Pharmacopœia for 1809. Sesquicarbonate of ammonia is to be added to a solution of carbonate of soda, at a heat of about 100° F. applied to drive off the ammonia: the solution is then to be set aside to crystallize. The proportions employed in the Pharmacopœia of 1809 were a pound of carbonate of soda, three parts of sesquicarbonate of ammonia, and a pint of distilled water. Mückler (Lehrb. d. Pharm. Chemie. 1er. Th. S. 292) directs 4 parts of crystallized carbonate of soda, 1½ parts of sesquicarbonate of ammonia,
and 10 parts of water. The proportions ordered by MM. Henry and Guibourt (Pharm. Raisonnée, t. 2nd. p. 469, ed. 2me.) are 6 parts of the crystallized carbonate of soda, 2 parts of sesquicarbonate of ammonia, and 4 parts of water.

Properties.—Bicarbonate of soda usually occurs in the form of a white crystalline mass. The perfect crystals are, according to Dr. Thomson (Chem. of Inorg. Bodies, vol. ii. p. 54), oblique rectangular prisms. The taste of this salt, and its reaction on vegetable colours, are slightly alkaline. By exposure to the air it effloresces superficially. When heated it evolves carbonic acid and water, and becomes the anhydrous carbonate. It dissolves in 13 parts according to Rose, or 8 parts according to Berthollet, of cold water. By heat the solution loses first one-quarter, and subsequently one-half of its carbonic acid.

Characteristics.—To recognize the carbonic acid and soda of this salt, the tests are the same as before described (vide p. 324) for the carbonate of soda. From the latter salt the bicarbonate of soda is distinguished by its causing neither a brick-red precipitate with the bichloride of mercury, nor a white precipitate with the sulphate of magnesia. The sodaic powder of the shops (soda sesquicarbonas, Ph. L.) being a mixture of carbonate and bicarbonate produces a red precipitate with bichloride of mercury, but no precipitate with sulphate of magnesia; and when washed with a small quantity of cold distilled water, leaves a white powder (bicarbonate of soda), which, when dissolved in water, gives a white precipitate or slight opalescence to a solution of bichloride of mercury.

Composition.—Crystallized bicarbonate of soda has the following composition:

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<tbody>
<tr>
<td>Soda</td>
<td>1</td>
<td>32</td>
<td>34'04</td>
<td>37</td>
<td>31'75</td>
<td>29'85</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>2</td>
<td>44</td>
<td>46'80</td>
<td>49</td>
<td>44'40</td>
<td>48'95</td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>18</td>
<td>19'14</td>
<td>14</td>
<td>23'85</td>
<td>20'26</td>
</tr>
<tr>
<td>Crystl. Bicarb. Soda</td>
<td>1</td>
<td>94</td>
<td>99'98</td>
<td>100</td>
<td>100'00</td>
<td>100'00</td>
</tr>
</tbody>
</table>

According to Dr. Thomson’s analysis (First Principles of Chemistry, vol. ii. p. 268), this salt contains only one equivalent of water of crystallization.

Purity.—When quite pure, this salt occasions no precipitate with chloride of platinum, perchloric acid, or tartaric acid, by which its freedom from potash is demonstrated. When supersaturated with pure nitric acid, it gives no precipitate with either chloride of barium or nitrate of silver, by which the absence of sulphates and chlorides is shewn. Lastly, it occasions a white precipitate with bichloride of mercury, by which the freedom from a simple or mono-carbonate is shewn.

Physiological Effects.—The effects of this salt are analogous to those of bicarbonate of potash, than which it is regarded as having a somewhat less disagreeable taste and a slighter local action. It is of course less caustic and irritant than the sesquicarbonate, and still more so than the carbonate of soda. Its remote or constitutional effects are analogous to those of the caustic alkalies. (Vide Potassa, p. 275.)

Uses.—It is employed as an antacid in those forms of dyspepsia which are attended with an inordinate quantity of acid in the stomach; as a lithontripic in those kinds of lithiasis which are accompanied with an
cessive secretion of uric acid and the urates; as a resolvent or alterative in certain forms of inflammation, in glandular affections, in syphilis, scrofula; and as a diuretic in some dropsical complaints. (For further particulars regarding these uses of bicarbonate of soda, vide Potassa, 277, et seq.)

The principal consumption of bicarbonate of soda (soda sesquicarbonas, Ph. L.) is in the preparation of the effervescent draught, soda-powders, and Seidlitz powders: in these the bicarbonate is mixed with a soluble acid (either citric or tartaric, usually the latter.) Taken in a state of effervescence, a solution of this kind is an agreeable and refreshing aid for allaying thirst, checking sickness, and diminishing febrile heat, and have before mentioned (p. 193.) The resulting soda-salt (tartrate or acid) undergoes partial digestion in its passage through the system, and is found in the urine in the state of carbonate. Hence, therefore, these effervescent preparations may be employed as diuretics and lithontriptics, to aid of the simple carbonate or bicarbonate of soda, than which they are more agreeable. On the other hand they are highly objectionable, and are to be carefully avoided, in the treatment of phosphatic deposits in the urine. Alluding to these cases Dr. Prout (Inquiry into the Nature of Affections of the Urinary Organs, 2d ed. p. 145) observes, "were I required to name the remedy calculated to do the most chief, I should name the common saline draught, formed of potash or soda, and some vegetable acid."

**ADDITION**—The dose of this salt is from ten grains to a drachm. The preparation of effervescent draughts, a scruple of the powder sold in the shops as bicarbonate of soda (soda sesquicarbonas, Ph. L.) usually requires about 18 grains of crystallised tartaric acid, or about 17 grains of the ordinary crystals of citric acid, or four drachms of lemon juice, to saturate it.

**SODAIC POWDERS.**—These consist of half a drachm of bicarbonate of soda, contained in a blue paper, and 25 grains of tartaric acid, in a white paper. When taken they should be dissolved in half a pint of water. The flavour of the solution is improved by adding to the water, while dissolving the acid, one or two drachms of simple syrup, and one half a drachm of the tincture of orange-peel, or two or three drops of the essence of lemon. The pulvis acrophorus et natro carbonico acidulo of the Prussian Pharmacopœia consists of a drachm of the bicarbonate, scrupules of tartaric acid, and the like quantity of white sugar. Ginger-beer powders are made in the same way as sodaic powders, except that five grains of powdered ginger and a drachm of white sugar are added with the bicarbonate of soda.

**Seidlitz Powders.**—These consist of two drachms of tartarized soda, and two scrupules of bicarbonate of soda contained in a blue paper, 30 grains of powdered tartaric acid in a white paper. These are to be dissolved in half a pint of water, while the liquid is in a state of effervescence. These form an agreeable and mild aperient. Why they are called Seidlitz powders I cannot divine, as they have no analogy to the bicarbonate of soda.

**Soda Water.** Properly so called: Liquor sodae effervescens, Ph. L. The greater part of the liquid sold in the shops as bottle-soda water, soda water from the fountain or pump, is merely a solution of carbonic acid in common water, effected by pressure, and, therefore, has no
claim to the denomination of soda water (vide p. 191). Some fe-
makers, however, prepare it by condensing carbonic acid in a solution of carbonate or bicarbonate of soda: this is soda water properly so called, for which are given in all the British Pharmacopoeias, as well as in the French Codex; but which I conceive are quite unnecessary, as this liquid can be prepared extemporaneously by adding bicarbonate of soda to the ordinary bottle-soda water. Thus, half a drachm of bicarbonate of soda and half a pint of bottle-soda water, will form a solution of the same strength as the liquor soda effervescens of the London Pharmacopoeia, which is directed to be prepared by dissolving a drachm of sesquicarbonate of soda in a pint of distilled water, and forcing into it an excess of compressed carbonic acid gas. The aqua carbonatis soda acidula (Ph. Dublin) is of the same strength: the aqua super-carbonata soda (Ph. Edinb.) contains 96 grains of carbonate of soda to a pound water.

A fraudulent imitation of soda water is said to have been practised by adding a few drops of sulphuric acid to a solution of carbonate of soda in water, and instantly corks the bottle. The fraud may be detected by chloride of barium, which throws down a white precipitate insoluble in nitric acid.

Soda water properly so called (liquor soda effervescens, Ph. L.) employed in the same cases as bicarbonate of soda. The addition of quantity of carbonic acid contained in it, renders it more agreeable and not less effectual, as an alkaline agent, in its operation on the system generally. It is employed to counteract or prevent the inordinate secretion of uric acid and the urates; but both this and soda water powder are highly injurious in phosphatic deposits,—in the latter case, however, carbonic acid water (ordinary bottle-soda water) may be used (vide p. 198).

Potas'sae Só'dio-Tar'tras.—So'dio-Tar'trate of Pot'ash.

History.—This salt was discovered by Seignette, an apothecary Rochelle, in 1672, and hence it is frequently termed Seignette's salt Sel de Seignette (Beckmann's Hist. of Invent. vol. iv. p. 616). He called it alkaline salt, sal polychrest, and Rochelle salt (sal rupellensis). To distinguish it from the sal polychrest (sulphate of potash) of other writers it is sometimes denominated sal polychrestum Seignetti. Its other names are, tartarized soda (soda tartarizata seu natron tartarizatum), or the tartrate of potash and soda. In the Pharmacopoeia it is termed soda potassio-tartratas.

Preparation.—The following are the directions for preparing the salt in the London Pharmacopoeia:—Dissolve 12 ounces of carbonate of soda in four pints of boiling water, and add, gradually, 16 ounces powdered bitartrate of potash. Strain the liquor; then apply a gentle heat until a pellicle floats, and set aside, that crystals may be formed. The liquor being poured off, dry these. Again evaporate the liquor, till it may yield crystals.

In this process the excess of acid in the bitartrate of potash is saturated by the soda of the carbonate, while the carbonic acid of the latter is disengaged.

Properties.—This salt is met with in large, transparent, and reg
SODIO-TARTRATE OF POTASH.

331

ly-shaped crystals, whose primary form is the right rhombic prism: curiously enough, the crystals are frequently produced in halves. Their taste is mildly saline and bitter. Exposed to the air they slightly etrose. When heated they undergo the watery fusion, evolve their er of crystallization, and are decomposed: the residue consists of recal and the carbonates of potash and soda. They are readily rible in cold, and still more so in hot water.

CHARACTERISTICS.—This salt may be recognised by the shape and of the crystals. Sulphuric acid added to the aqueous solution-throws small crystals of bitartrate of potash; perchloric acid throws down hlorate of potash: the chlorides of barium and calcium occasion ite precipitates, soluble in excess of water, and composed of soda, taric acid, and, in the once case, baryta, in the other lime: chloride platinum produces a yellow precipitate of the platinum-chloride of assium. Nitrate of silver occasions a white precipitate (tartrate of er), soluble in excess of water. When heated, potash-tartrate of a is decomposed, evolves various volatile substances, and gives out odour of carouel. If the residuum be digested in hydrochloric acid, obtain a solution of the chlorides of sodium and potassium: the ride of potassium may be precipitated by chloride of platinum, rying chloride of sodium in solution, which may be detected by the as already mentioned for this salt (p. 310).

COMPOSITION.—The composition of this salt is as follows:—

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Schulze.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>1</td>
<td>32</td>
<td>10.6</td>
</tr>
<tr>
<td>Potash</td>
<td>1</td>
<td>132</td>
<td>33.6</td>
</tr>
<tr>
<td>Tartrate Acid</td>
<td>2</td>
<td>43.7</td>
<td>10.8</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>29.8</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Cryst. Sodio-Tart. of Potash 1 ... 302 ... 99.7 ... 100.0

Thomson (First Principles, ii. 440) says, that when the crystals are from all adhering moisture they contain only eight equivalents of er of crystallization, and their atomic weight is then 284.

PHYSIOLOGICAL EFFECTS.—It is a mild, laxative, cooling salt, very llogous in its effects to the tartrate of potash. Sundelin (Heilmittel.) as it is uncertain as a purgative, sometimes failing, at others acting slowly, but strongly, and with violent abdominal pain. He thinks may be completely replaced in practice by a mixture of magnesia and whate of magnesia. Like the other vegetable alkaline salts, it under- partial decomposition in the system, and is converted into the car- rate, in which state it is found in the urine. Hence its use should be fully avoided in persons suffering with phosphatic deposits in the e.

USES.—It is commonly employed as a mild aperient for females and er delicate persons. It may be used with advantage by those who subject to excessive secretion of uric acid or the urates.

ADMINISTRATION.—It is given in doses of from half an ounce to an ounce. It should be exhibited largely diluted with water. A very con- mode of exhibition is in combination with bicarbonate of soda tartaric acid in an effervescent condition (vide Seidlitz Powders, 229).
So'dae Ac'e'tas.—Ac'e'tate of So'da.

History.—This salt was first described by Baron, in 1747 (Thomson's Chemist. of Inorg. Bod. vol. ii. p. 464): but according to Dulk (die Preuss. Pharm. übers. v. erläut.) its real discoverer was F. Meyer, in 1677. It was formerly called terra foliata tartari crystallisata, or terra foliata mineralis.

Preparation.—It may be readily procured by saturating carbonate of soda by distilled vinegar (as directed in the Dublin Pharmacopoeia), evaporating the solution and crystallizing. In this process the acetic acid expels the carbonic acid with effervescence.

On the large scale acetate of soda is obtained by manufacturers of pyroligneous acid by the following process:—Rough or impure pyroligneous acid is saturated with either slacked lime or chalk. In this way there is formed an impure acetate of lime (commonly termed pyrolignat of lime). To the clear solution is added sulphate of soda. Double decomposition takes place: sulphate of lime precipitates, and acetate of soda remains in solution. The clear liquid is then evaporated and crystallized. The impure acetate of soda thus procured is purified by drying, solution in water, re-crystallization, fusion in an iron pot, expulsion of the water of crystallization by heat, incipient carbonization to decompose the impurities of the salt, re-solution, and re-crystallization.

Properties.—The primary form of the crystals of this salt is the oblique rhombic prism. Geiger (Handb. d. Pharm. 1 Bd. 150, 3 Aufl.) says that a saturated solution of this salt does not readily crystallize when cooled in a tall glass vessel unless some pointed or angular body be introduced. Its taste is cooling, saline, and bitterish. Exposed to the air, at ordinary temperatures, the crystals undergo little change; but in dry and warm air they effloresce and become anhydrous. When heated they first undergo the watery fusion, then give out their water of crystallization, and afterwards undergo the igneous fusion. At a red heat they are decomposed, and give, as a residue, a mixture of charcoal and carbonate of soda. They are soluble in about 3 parts of cold water; and at slightly soluble in alcohol.

Characteristics.—As an acetate it is recognized by the tests before mentioned (p. 222) for this class of salts. That the base is soda is shown by the characters already described (p. 310) for the soda salts.

Composition.—The following is the composition of this salt:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Berzelius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soda</td>
<td>1</td>
<td>32</td>
<td>23·36</td>
<td>22·94</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>1</td>
<td>51</td>
<td>37·22</td>
<td>36·95</td>
</tr>
<tr>
<td>Water</td>
<td>6</td>
<td>54</td>
<td>39·41</td>
<td>40·11</td>
</tr>
</tbody>
</table>

Crystallized Acetate of Soda. 1 137 99·99 100·00

Purity.—It should be white and perfectly neutral to test-paper (litmus and turmeric.) The presence of sulphuric acid may be recognized by chloride of barium, which occasions, with this acid, a white precipitate insoluble in nitric acid. If nitrate of silver cause a white precipitate insoluble in both water and nitric acid, but soluble in ammonia.
the presence of a chloride is to be inferred. Potash may be recognised by the before-mentioned tests for this base (p. 274), as well as by the liquefactive property of the suspected acetate.

Physiological Effects.—Acetate of soda operates on the body like the acetate of potash, but is probably somewhat milder in its action.

Uses.—It is rarely employed for medicinal purposes. It may, however, sometimes be used as a substitute for acetate of potash, over which it has the advantage of not being deliquescent.

In pharmacy and the arts it is largely employed in the manufacture of oleic acid (vide p. 221), and on this account has been introduced into the Pharmacopoeia, as the official source of this acid.

Administration.—The dose of it, as a diuretic, is from a scruple to a drachm.

Sa'po.—Soap.

History.—The Hebrew word borith, translated in our version of the Bible (Jer. ii. 22, and Mal. iii. 2), soap, is, by most commentators supposed to refer to a plant, or to the alkaline ashes of some plant. Pliny, in (Hist. Nat. xxviii.) mentions soap, says it is made of tallow and ashes, ascribes its invention to the Gallis, and adds, that the Germans employed both thick and liquid soap (hard and soft soap?) In the excavations made at Pompeii, a complete soap-boiler's shop was discovered, with the soap still perfect, though it must have been manufactured for more than 200 years (Parkes, Chem. Essays, ii. 5, 2nd. ed.)

Natural History.—Soap is always an artificial product, unless the spontaneous formation of adipocire, from dead animal matter, be considered an exception to this statement. This substance appears, from the analysis of Chevreul, to consist of a small quantity of ammonia, of potash, and lime united to much margaric acid, and a very little oleic acid.

Preparation.—The manufacture of soap varies according to the quality of this substance intended to be produced.

The soaps employed in medicine are those which contain, as their base, potash, soda, ammonia, lime, or oxide of lead: the three first are called soluble—the two latter insoluble soaps. Of these five, two only require notice at present, viz. those which contain either soda or potash: and for an account of the three other soaps I must refer to the articles Nimentum Ammonii (p. 176), Linimentum Calcis, and Emplastrum Columbi.

1. Of Soda Soap (sapo sodaicus: s. natrinus: s. durus: s. spissus of Pliny?) The quality of this kind of soap varies according to the kind of potash or resinous matter used in its manufacture.

(a.) Olive oil soda soap (sapo ex olivae oleo et sodâ confectus, Ph. L. sopo durus, Ph. Dub. Sapo Hispanicus.)—This is made by boiling olive oil with a solution of caustic soda (prepared by the action of lime on barilla or some other impure carbonate of soda) till the soap separates, and afterwards remelted in water to remove any adhering koli. When sufficiently cold it is run into frames (wooden troughs with moveable bottoms), and after it has acquired sufficient firmness, it is cut into long cakes or bars by means of a wire. (For further details, consult Aikin's Dict. of Chemistry, art. Soap.)

There are two varieties of olive oil soda soap—one white (sapo albus)
—another, marbled or mottled. The soap sold in the shops as Castile soap (sape castiliensis) is of the latter kind: “the marbled appearance which it presents is produced by the addition of sulphate of iron to a part of the alkaline ley, after the soap is fully boiled, which gives the blue colour; and the stirring in red oxide of iron, when the soap is almost made, gives the red colour.” (Thomson’s London Dispensatory. The marbling, or mottling, therefore, is an impurity.

(b.) Almond oil soda soap (sape amygdalinus. Fr. Codex.)—This is the medicinal soap (sapon medicinal) of the French; directions for preparing which are contained in the French Codex.

(c.) Animal oil soda soap (sape sebaceus, Geiger: sapo vulgaris, United States Ph.)—Of this two kinds are in common use in this country. The best is that called white card soap, and which is prepared from pure or white tallow and soda: when scented it constitutes Windsor soap. The common or domestic soap, usually termed mottled soap, is made with refuse kitchen grease (commonly called kitchen stuff).

(d.) Resin soda soap.—This is the common yellow soap of the shops, and is the commonest of the hard soaps of this country. It owes its peculiar properties to the admixture of resin and palm oil with animal fat.

Besides the above, there are many other varieties of hard soap, termed fancy soaps, sold by perfumers. The patent silica soap consists of the usual kinds of soaps to which precipitated silica is added.

2. Of Potash Soap. (sape potassicus: s. kalinus: s. mollis: s. liquidus, Pliny?)—This kind of soap is made with caustic potash instead of caustic soda.

(a.) Olive oil potash soap (sape mollis,—sape, ex olive oleo et potassia confectus, Ph. L.)—No soap of this kind is made or known in London. I am informed by Messrs. Rowe, of Brentford (the most extensive manufacturers of soap in the neighbourhood of the metropolis), that they are unacquainted with it. On inquiry I find that a white soft soap, made by Mr. Taylor, 13, Newington Causeway, is used at Apothecaries’ Hall, in the preparation of Ung. Sulph. Co. Ph. L.; but I have been unable to procure a sample of it. Mr. Taylor tells me it is only made to order, as there is very little demand for it, the principal consumption being at Apothecaries’ Hall. He also informed me, that it was made from three fatty substances (olive oil, tallow, and some other oil), and two alkalies (potash and soda)—that it is white, and has the consistence of butter, but by keeping becomes harder.

(b.) Animal oil potash soap.—This is the common soft soap of the shops, and which is made with fish oil (whale or cod), tallow and potash. (For particulars respecting its manufacture consult Ure’s Dict. of Chem., art. soap.)

Theory of Saponification.—Soaps are to be regarded as alkaline salts, formed by the action of alkaline bases on fatty or resinous bodies. At one time it was supposed that they were mere compounds of fat or resin and of alkali; but it is now known that in the process of saponification, the organic constituents (stearine, margarine, and olein) of vegetable and animal fats undergo certain chemical changes by which acids (stearic, margaric, and oleic) are produced, which, combining with the bases, form the salts (stearates, margarates, and oleates) commonly termed soaps; and at the same time a sweet substance (glycerine) is generated. Thus it appears that, by the influence of an alkali, one equiva-
or 564 parts of stearine are converted into one equivalent or 527 parts of anhydrous stearic acid, and one equivalent or 37 parts of anhydrous glycerine; the stearic acid unites with the alkali to form soap. The following diagram illustrates these changes:

\[
\begin{align*}
1 \text{ eq. Anhyd. Starch Acid} &= 527 \\
3 \text{ eq. Carb.} &= 483 \\
3 \text{ eq. Carb.} &= 18. \\
70 \text{ eq. Carb.} &= 420. \\
67 \text{ eq. Hydr.} &= 67. \\
3 \text{ eq. Hydr.} &= 3. \\
70 \text{ eq. Hydrog.} &= 70. \\
5 \text{ eq. Oxyg.} &= 40. \\
2 \text{ eq. Oxyg.} &= 16. \\
7 \text{ eq. Oxygen} &= 56. \\
1 \text{ eq. Anhyd. Glycerine} &= 37.
\end{align*}
\]

In the conversion of resin into soap the phenomena are different. Resins consist of one or more acids, which combine with alkalies to form monos salts or soaps. Thus ordinary yellow resin (or rosin) consists of two acids, called respectively pimic and silvic acids; and a soda soap made of this substance would, therefore, be a mixture of pinate and stearic acid.

**Properties.**—The consistence, colour, odour, and sp. gr. of soap vary in the different kinds. The taste of all is slightly alkaline. All alkaline soaps are soluble both in water and alcohol. The substance called *transparent soap* is prepared by evaporating an alcoholic solution of pure soap. When heated soap fuses, swells up, and is decomposed, leaving a residuum of charcoal and alkaline carbonate. Most of the acids compose soap; they unite with the alkaline base and separate the fatty acids. The earthy salts (as sulphate of lime, sulphate of magnesia, alum, &c.) also decompose soap: the fatty acids unite with the earth to form insoluble earthy soap, while the alkali of the soap combines with the salt of the earth. The hardness of sea, spring, and well water, depends on the earthy salts (principally sulphate of lime) which decompose soap.

No tincture of soap may be used as a test of the hardness or softness of common waters. The metallic salts also decompose soap, and give rise to metallic soaps.

**Olive oil soda soap** may be either white or marbled, as before stated. When pure it has very little odour. It is hard, but in the fresh state may easily be worked or kneaded between the fingers: by keeping in warm and dry it becomes dry and pulverizable. It should not feel greasy, have a bad odour, communicate an oily stain to paper, nor be covered with a white efflorescence; but should dissolve completely and readily in both water and alcohol. The marbling, as I have before stated, is an impurity.

**Animal oil potash soap** (common soft soap) is of a brownish or yellowish colour; transparent, but interspersed with white specks, owing to an admixture of tallow.

**Characteristics.**—Soap may be partly recognised by its physical properties, especially by its feel, which is so well known that it is usually said *soapy*. The solubility of soap in water and alcohol is an important character, as well as its detergent quality, which depends on its power of rendering fatty and other matters soluble in water. The effect of heat on it also deserves notice: if the carbonaceous residuum be tested in weak hydrochloric acid, and the solution filtered and concentrated by evaporation, the nature of the alkaline base may be ascertained by applying the tests for potash and soda before mentioned (pp. 274 and 1). Lastly, the action of acids and earthy and metallic salts on a solution of soap, as already noticed, serves to recognise soap.
Composition.—The following is the composition of several varieties of soap:

<table>
<thead>
<tr>
<th>OLIVE OIL SODA SOAP.</th>
<th>ANIMAL OIL POTASH SOAP.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Marseilles white.</td>
<td>Marseilles Marbled.</td>
</tr>
<tr>
<td>Soda</td>
<td>10:24</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>9:20</td>
</tr>
<tr>
<td>Oleic acid</td>
<td>59:20</td>
</tr>
<tr>
<td>Water</td>
<td>21:36</td>
</tr>
<tr>
<td>Olive oil soda soap</td>
<td>100:00</td>
</tr>
<tr>
<td>(Bracconot.)</td>
<td>100</td>
</tr>
<tr>
<td>(D'Arcet.)</td>
<td>100.0</td>
</tr>
<tr>
<td>(Thenard)</td>
<td>(Ure.)</td>
</tr>
<tr>
<td>London-made</td>
<td>Castle, very dry.</td>
</tr>
<tr>
<td>Soda</td>
<td>10:05</td>
</tr>
<tr>
<td>Fatty acids</td>
<td>75:2</td>
</tr>
<tr>
<td>Water</td>
<td>14:3</td>
</tr>
<tr>
<td>Animal oil potash</td>
<td>10</td>
</tr>
<tr>
<td>Soap</td>
<td></td>
</tr>
<tr>
<td>Potash</td>
<td></td>
</tr>
<tr>
<td>Fatty acids</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
</tbody>
</table>

For analyses of other kinds of soap I must refer the student to Ur. Dict. of Chemistry, and Gmelin's Handb. d. Chemie. The atomic constitution of soap cannot be determined with accuracy, on account of the great variation in the quantity of water. The relative proportion of acid and base appear to be nearly one equivalent of the fatty acid to two the alkali. Thus, olive oil soda soap may be regarded as a compound one equivalent or 518 parts of oleic acid, and two equivalents or 64 parts of soda, exclusive of the water and the small quantity of stearate (margarate) of soda present.

Purity.—The adulterations of soap are excess of water, lime, gypsun, or pipe-clay. The first may be known by the consistence of the soap and the great loss of weight which this substance undergoes in dry air. The other impurities may be detected by alcohol, which leaves the undissolved.

Physiological Effects. (a.) On vegetables.—Soap, used as a manure appears to promote vegetation (Decandolle, Physiol. Végét. p. 1343).

(b.) On animals.—It does not appear to be poisonous to animal. Veterinarians employ it as a diuretic, and, in large doses, as a purgative.

(c.) On man.—Soap acts very much like the alkalies (vide Potass. p. 275). Its local operation, however, is much less energetic than either the caustic or even the carbonated alkalies. Hence it may be administered in considerable doses without causing irritation or inflammation. When swallowed it very readily palls the appetite and disturbs the digestive functions, and in these qualities it is more powerful than the alkali. Perhaps these effects depend on the fatty acids which must be disengaged in the stomach, in consequence of the union of the alkali of the soap with the free acids of the gastric juice. Probably the fatty acids become more or less completely digested, for soap acts on the general system like the alkalies; it promotes the secretion of urine, and communicates alkaline properties to this fluid. In large doses, soap acts as a purgative. I knew an idiot who had frequently eaten large lumps of soap without any ill effects; and I have heard of a pound of it being swallowed for wager!

Uses.—As an antacid, soap is employed in poisoning by the mineral acids: it should be administered in the form of a strong solution, which effectually neutralizes the acid without acting as an irritant. So also those forms of dyspepsia which are attended with an excessive formation of acid, soap may be usefully employed to neutralize it. External pain burnt with the strong mineral acids, or with phosphorus, should be washed with a solution of soap. As a lithotriptic, soap has been used in those forms of lithiasis in which uric acid or the urates prevail. A mixture of soap and lime-water was once considered a most powerful
vent for urinary calculi. The Hon. Horace Walpole (Philosophical Transactions, xlvii. 43 & 472) gained great relief from it. By the action of lime-water on soap, an insoluble calcareous soap and a solution of caustic soda are formed. As a purgative, soap is rarely exhibited alone: in combination with rhubarb it may be employed with considerablc benefit in habitual constipation and disordered conditions of the biliary functions. In the form of enema, a strong solution of soap is sometimes used with great relief to dissolve hardened feces, and relieve obstinate constipation. As a resolvent or alterative, soap was once much esteemed in enlargements and various chronic disorders of the viscera and glands; and as the alkalies have been found useful in the same diseases, any good effects which may have been obtained by soap are probably referrible to its alkaline base.

Externally, soap is frequently employed on account of its detergent, lubricating, and discutient qualities. Thus, in linea capitis, scabies, and various other skin diseases, ablation night and morning with soap-water ealy contributes to the cure. On account of its lubricating qualities, soap is a most convenient adjunct to liniments. The uses of the liniment, cerate, and plaster of soap, are noticed below.

Lastly, soap is useful in pharmacy to render other medicines more soluble, or to give a proper consistence to various substances for the making of pills. Thus it is a constituent of various pills (e.g. pil. rhei m., pil. sap. comp., and pil. scillæ comp.) In some cases it acts as an adjuvans, assisting and promoting the operation of other medicines; as a corrector, correcting their operation; and as a constitutans, imparting agreeable or convenient form. The addition of soap to aloes or extract of jalap is cited by Dr. Paris (Pharmacologia) as an instance in which soap fulfills all three of these objects.

Administration.—The usual dose of soap, taken in a pilular form, is from five grains to half a drachm. In cases of poisoning by the mineral acids, half a pint of a strong solution of soap should be instantly administered.

1. Linimentum Saponis, Ph. L. & D. (soap, 3iii.; camphor, 3i.; spirit of rosemary, f. 3xvi.): Tinctura Saponis Camphorata, Ph. Ed. & U.S. (soap, 3iv.; camphor, 3ii.; oil rosemary, f. 3ss.; alcohol, f. 3xxxii.) Drugs frequently substitute soft soap (animal oil potash soap) for the olive oil soap of the Pharmacopæia. Soap liniment or opodeldoc is used as a stimulant and discutient, as well as, on account of its lubricating qualities, in local pains, sprains, bruises, rheumatism, &c. When mixed with three-fourths of its volume of tincture of opium, it constitutes theodyne liniment (linimentum saponis cum opio, vel linimentum anodynum) the Dublin Pharmacopæia.

2. Ceratum Saponis, Ph. L. (soap, 3x.; wax, 5xiiss.; oxide of lead, powdered, 3xv.; olive oil, Oj.; vinegar, Cj.)—The subacetate of lead, made by boiling oxide of lead with vinegar, is decomposed by the soap, a fatty acids (oleic and margaric) unite with the lead. The wax and oil serve to give consistence to the preparation. Soap cerate is used as a cold cooling dressing for scrofulous swellings, and other local inflammations, as well as for fractured limbs: in the latter case its principal use as a mechanical support.
3. Emplastrum Saponis, Ph. L. & Dub. (soap, lb. ss.; lead plaster, lb. iii.) This quantity of soap is said to be too much by one half. This plaster, spread on leather, is employed as a discutient and mechanical support. When two parts of it are mixed with three parts of resinous plaster (emplastrum resine, Ph. L.), it constitutes the emplastrum saponis compositum, vel emplastrum adherens, Ph. D., and which, when spread by a machine on linen, is sold in the shops by the name of adhesive plaster (Dr. Duncan, Edinb. Dispensatory).


Baryta Carbonas.—Carbonate of Baryta.

History.—The earthy base called baryta was discovered in 1774 by Scheele. It was at first termed terra ponderosa. In 1783 Dr. Withering recognised the native carbonate of baryta, which has been called, after its discoverer, Witherite.

Natural History.—Witherite occurs in the lead mines of the north of England (as those of Anglesey, in Lancashire), and in various other localities. The mineral called baryto-calcite (a compound of carbonate of baryta and carbonate of lime) is found at Alston Moor, Cumberland.—[For some curious anecdotes respecting its discovery at the latter place, consult Parkes's Chem. Essays, vol. i. p. 324].

Preparation.—The native carbonate of baryta is sufficiently pure for the preparation of the other barytic salts, and is the kind meant in the Pharmacopoeia. Absolutely pure carbonate may be prepared by the addition of a pure alkaline carbonate to a solution of some barytic salt, as the sulphuret (obtained from the decomposition of the sulphate of some carbonaceous matter), or the chloride; or it may be obtained by igniting (or boiling in water) finely powdered sulphate of baryta with three parts of carbonate of potash, and washing away the resulting sulphate of potash; or by decomposing sulphate of baryta by carbonate of ammonia.

Properties.—Native carbonate of baryta occurs massive, stalactitic and crystallized: the primary form of the crystals is the right rectangular prism. The sp. gr. of this mineral is 4·3. Heated before the blowpipe it melts into a white enamel, with the evolution of much light and the loss of carbonic acid. Artificially prepared, carbonate is a fine, tasteless, odourless powder. It is almost insoluble in both hot and cold water, 4,304 parts of cold, or 2,304 parts of hot water, being required to dissolve one part of carbonate. It is more soluble in carbonic acid water.

Characteristics.—It dissolves with effervescence in hydrochloric acid, forming a solution of chloride of baryum: the evolved gas, when collected, is found to be carbonic acid (vide p. 190). The hydrochloric solution is not precipitated by ammonia, the hydrosulphurets, or the ferrocyanides; but the soluble sulphates, phosphates, and carbonates throw down white precipitates, which are, respectively, sulphate, phosphate, oxalate, and carbonate of baryta: sulphate of baryta is insoluble in both water and nitric acid. The salt (chloride of baryum) obtained by the evaporation of the hydrochloric solution, tinges the flame alcohol greenish yellow.
COMPOSITION.—The following is the composition of this salt:—

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</thead>
<tbody>
<tr>
<td>Baryta</td>
<td>1</td>
<td>77</td>
<td>77·7</td>
<td>77·9</td>
<td>78</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>1</td>
<td>22</td>
<td>22·2</td>
<td>22·1</td>
<td>22</td>
</tr>
<tr>
<td>Carbonate Baryta</td>
<td>1</td>
<td>99</td>
<td>99·9</td>
<td>100·0</td>
<td>100</td>
</tr>
</tbody>
</table>

PURITY.—It should be white, odourless, and tasteless. Neither caustic ammonia nor hydro-sulphuric acid should produce any precipitate or change of colour in the hydrochloric solution, by which the absence of alumina and metallic matter may be inferred. If excess of sulphuric acid be added to this solution, no precipitate should be occasioned by the subsequent addition of carbonate of soda, by which the absence of lime is shown.

PHYSIOLOGICAL EFFECTS. (a.) On vegetables.—Germination does not take place in carbonate of baryta. (Vogel, in Decand. Phys. Végét. 1341.)

(b.) On animals.—Cows and fowls have been destroyed by swallowing the native carbonate. (Parkes, Chem. Essays, vol. i. p. 330.) Orfila (Toxicol. Gén.) says a drachm of the powder killed a dog in six hours; but C. G. Gmelin (Versuche über d. Wirk. des Baryts, &c. p. 8) gave two drachms to a dog: vomiting took place, and the animal was well the next day. A drachm killed a rabbit in three hours. When applied to a wound it has proved fatal. (Campbell, quoted by Christison, Treatise on poisons, 3d ed. p. 532.) From the above experiments carbonate of baryta appears to act as an acro-narcotic poison: when swallowed it causes vomiting, inflames the alimentary tube, becomes absorbed, and acts specifically on the nervous system, causing convulsions, paralysis, and insensibility.

(c.) On man.—Only one case illustrating its action on the human subject has been published. (Dr. Wilson, Med. Gaz. vol. xiv. p. 487.) A young woman swallowed half a tea-cupful of the powdered carbonate: two hours she had dimness of sight, double vision, ringing in the ears, pain in the head, and throbbing in the temples, a sensation of distension and weight at the epigastrium, distension of stomach, and palpitation. Subsequently she had pains in the legs and knees, and cramps in the limbs. A day or two after the cramps became more severe. These symptoms slightly modified continued for a long time.

USES.—Carbonate of baryta is employed in the preparation of the chloride of baryum. It is not administered as a medicine.

ANTIDOTE.—(Vide Barii Chloridum.)

Ba'rii Chlo'ridum.—Chlo'ride of Ba'rium.

HISTORY.—This compound was discovered by Scheele in 1775. It was at first termed terra ponderosa salita, and afterwards muriate of barytes.

PREPARATION. 1. From the native carbonate of baryta.—The following are the directions given in the London Pharmacopoeia:—Add ten ounces of carbonate of baryta, broken in small pieces, to half a pint of hydrochloric acid mixed with two pints of distilled water. Apply heat, and
when the effervescence has finished, strain and boil down, that crystals may be formed.

In this process one equivalent or 37 parts of hydrochloric acid react on one equivalent or 99 parts of carbonate of baryta: the products are one equivalent or 22 parts of carbinic acid, which escape; one equivalent or 9 parts of water, and one equivalent or 105 parts of chloride of baryum.

2. *From the native sulphate of baryta.*—As a sulphate of baryta can be obtained in greater abundance and cheaper than the carbonate, manufacturers usually prepare the chloride, as well as other salts, of baryum from it. There are several modes of proceeding, but the most common one is the following:—Make finely powdered sulphate into a paste with about an equal volume (or a sixth part of its weight) of flour (or charcoal); and expose it in a covered crucible to an intense heat for two hours. The carbon combines with the oxygen of the sulphuric acid and of the baryta, and forms carbonic oxide, which escapes. The residue digested in water forms a solution of sulphuret of baryum. To the filtered liquor add hydrochloric acid, which causes the evolution of hydrosulphuric acid gas; filter the solution, evaporate, and crystallize. By re-solution, evaporation, and a second crystallization, the crystals may be obtained very pure and fine. Or sulphate of baryta may be decomposed by igniting it with chloride of calcium.

**Properties.**—Chloride of baryum crystallizes in right rhombic plates or tablets, sometimes in double eight-sided pyramids: the primary form of the crystals is the right rhombic prism. To the taste this salt is disagreeable and bitter. Its sp. gr. is 2·825. In dry warm air the crystals effloresce, but in the ordinary states of the air they undergo no change. When heated they decrystallize, lose their water of crystallization, and at a red heat fuse. At a white heat, according to Planyjava, this salt volatilizes. It is soluble in both cold and hot water: 100 parts of water at 60° dissolve 43·5 of the crystallized salt,—at 222°, 78 parts. It is slightly soluble in ordinary rectified spirit, but is said to be insoluble in pure alcohol.

**Characteristics.**—That it is a chloride is readily known by nitrate of silver (vide p. 105.) The tests by which the nature of the base can be determined have been before mentioned (p. 338.)

**Composition.**—The crystals of chloride of baryum have the following composition:

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Barium</td>
<td>1</td>
<td>69</td>
<td>56·09</td>
<td>85·201</td>
<td>85·5</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1</td>
<td>36</td>
<td>29·26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>18</td>
<td>14·63</td>
<td>14·799</td>
<td>14·5</td>
</tr>
<tr>
<td>Cryst. Chlor. Baryum</td>
<td>1</td>
<td>123</td>
<td>99·98</td>
<td>100·000</td>
<td>100·0</td>
</tr>
</tbody>
</table>

**Purity.**—The crystals should be colourless, neutral to test paper, permanent in the ordinary states of the air, (if they become moist or deliquesce, the presence of chloride of calcium, or chloride of strontium, may be suspected), and their aqueous solution should undergo no alteration of colour by the addition of ferrocyanide of potassium, hydrosulphuric acid.
nure of nutgalls, or caustic ammonia, by which the absence of metallic matter (as iron, lead, or copper), may be inferred. If excess of sulphuric acid be added, the filtered solution should be completely volatile when heated, and should occasion no precipitate on the addition of carbonate of soda, by which the absence of lime or magnesia is proved.

**Physiological Effects.**

(a.) *On vegetables.*—This salt is poisonous plants. (Marcet, quoted by Decandolle, *Phys. Végét.*

(b.) *On animals.*—The action of chloride of barium on animals is, according to Sir B. Brodie (*Phil. Trans. 1812, p. 205*), analogous to that of arsenic. Locally it operates as an irritant. After absorption it affects the nervous system, the organs of circulation, and the stomach. Its action the nervous system is manifested by staggering, convulsions, paralysis, and insensibility; on the circulating system, by palpitations, with feeble and intermittent pulse; on the stomach, by vomiting from its application a wound. According to Sir B. Brodie the affection of the stomach is lighter than that caused by arsenic. (See also the experiments of Orfila the *Toxicol. Génér.,* and of C. G. Gmelin in his *Versuche über die Wir-\n\n(c.) *On man.*—Administered in small doses, it at first produces no very obvious effects. In some cases the appetite appears to be improved. On we observe an increased secretion of urine, tendency to sweating, and not infrequently loose stools. With no other obvious symptoms on these, glandular swellings or enlargements sometimes become softer and smaller, from which we infer that the absorbent system is stimulated greater activity. If we persevere in the use of gradually increased doses, the appetite becomes disordered, nausea and vomiting, with not infrequently griping and purging, come on: a febrile state, with dry tongue, is produced, the nervous system becomes affected, and the patient complains of giddiness and muscular weakness. Sometimes, according Schwilghe (*Traité de Mat. Méd. vol. i. p. 441, 3\textsuperscript{me}. cd.*) under the continued use of it, catarrhal discharges from the eye, nose, ear, &c. take place; inflamed or suppurating lymphatic glands evince signs of an augmented excitation, wounds assume a more healthy appearance, and, in some cases, cicatrize.

In large medicinal doses very unpleasant effects have been occasionally observed from its use; such as vomiting, purging, sometimes griping, attracted pulse, giddiness, and great muscular debility, almost amounting to paralysis, with trembling. (See an illustrative case in *Medical commentaries, xix. 267.*

In excessive or poisonous doses (as an ounce) the affection of the nervous system is more obvious. In one recorded case the symptoms were convulsions, pain in the head, deafness, and, within an hour, death. (*Journ. Science, vol. ix. p. 382.*

In conclusion, it may be observed, that considered medicinally chloride of barium is most analogous to, though more powerful than, chloride of calomel, and is applicable in the same cases: regarded toxicologically it may compared to arsenic, but it acts less energetically on the stomach, and are rapidly on the nervous system, and causes death in a shorter time.

**Uses.**—The principal medicinal use of chloride of barium is in the treatment of scrofula, for which it was introduced into medicine by Dr. Lawford in 1790 (*Med. Commentaries, Dec. 2d, vol. iv. p. 433, and ed. Communications, vol. ii.*), and was subsequently employed by Hufe-
Berl. 1794), with great benefit. The latter writer has employed it in all
the forms of this disease, but especially in excited and inflamed condi-
tions, (particularly of delicate and sensible parts, as of the lungs and eyes
in painful ulcers, indurations which are disposed to inflame, and cuta-
neous affections. It has also been administered as a resolvent, depo-
struent, or alterative, in some other diseases: for example, scirrhus an
cancer, cutaneous diseases, bronchocele, &c. As a local application,
solution of it has been used as a wash in herpetic eruptions, and as
collyrium in scrofulous ophthalmia.

In pharmacy and chemistry it is extensively employed as a test for
sulphuric acid and the sulphates.

Administration.—It is used in the form of aqueous solution. Th
Liquor Barii Chloridi, Ph. L. consists of a drachm of the sa
dissolved in an ounce of distilled water. The dose is ten drops gradu-
ally and cautiously increased until nausea or giddiness are experi-
enced.

The officinal solutions of the Edinburgh and Dublin Pharmacopoeias are
about 2½ times stronger. Common water, and all liquids contain-
ing carbonates, phosphates, or sulphates, are incompatible with it.

Antidotes.—The antidotes for the barytic salts are the sulphate
which form therewith an insoluble sulphate of baryta. Hence sulphate
of soda, sulphate of magnesia, or well or spring water (which contain
sulphate of lime) should be copiously administered. Of course the poi-
son should be removed from the stomach as speedily as possible. To
appease any unpleasant symptoms caused by the continued use of large
medicinal doses, opiates may be employed.

Order 13. Compounds of Calcium.

Calx.—Lime.

History.—Lime, and the mode of obtaining it by burning the carb-
nate, were known in the most remote periods of antiquity. Hippocra-
t (Popularium, ii. sect. 5) employed this earth in medicine. Dr. Black in 173
first explained the nature of the process for making it. In 1808 Dav-
shewed that this substance was a metallic oxide, and hence it has been
termed the oxide of calcium. To distinguish it from the hydrate of lime
it is termed caustic or quicklime (calx viva), or burned lime (calx usta).

Natural History.—It occurs in both kingdoms of nature.

(a) In the inorganic kingdom.—In the mineral kingdom lime
found in the form of carbonate, sulphate, phosphate, silicate, arseni-
tungstate, borate, and titanate. Its base, calcium, occurs in combi-
tion with fluorine. “Lime is also disseminated through sea water
though in small quantities; so that calcium is widely distributed in land
and water, being principally abundant in the central and higher parts
the fossiliferous rocks, and widely dispersed, in small quantities, through
out the more ancient rocks, and in the waters of the sea.” (De la Beel
Research. in Theor. Geol. p. 21.)

(b) In the organized kingdom.—In vegetables, lime (or calcium) is
invariable ingredient, except, it is said, in the case of Salsola Kali. (D
candolle, Phys. Végét. p. 382.) It is found combined with carbonic, su
uric, phosphoric, nitric, and various organic acids (as oxalic, malic, uric, tartaric, and kinic): calcium occurs in combination with chlorine. Animals lime is found principally as carbonate and phosphate.

Preparation.—For use in the arts lime is usually obtained by burning the carbonate with coals, coke, or other fuel, in a kind of wind furnace called a kiln (vide Loudon's Encycl. of Agricult. 3d ed. p. 625; and Ray's Operative Chemist.) In the Dublin, Edinburgh, and United States Pharmacopoeias, the official lime is the lime of commerce: but as it contains various impurities, the London Pharmacopoeia directs lime to be prepared by exposing chalk to a very strong fire during an hour, which the carbonic acid is expelled. White Carrara marble yields the purest lime.

Properties.—Lime (commonly termed quicklime) when pure is a white, greyish white solid, having a sp. gr. of 2·3. It has an acrid, alkaline taste, and reacts powerfully on vegetable colours as an alkali. It is difficult of fusion: but by the oxy-hydrogen flame it may be both fused and slaked. Exposed to the air it attracts water and carbonic acid. If a small portion of water be thrown on lime, part of it combines with the lime, and thereby causes the evolution of a considerable degree of heat, by which another portion of the water is vaporized. The lime swells up, cracks, and subsequently falls to powder: in this state it is called slacked lime (calx extincta), or the hydrate of lime. By heat the water may be again expelled.

Lime dissolves in water, forming lime-water or aqua calcis. It is prepared by first slacking lime and then adding more water: the proportions employed by the London College are half a pound of lime to three gallons of water. The solution should be kept in stopped glass vessels with the undissolved lime, and when used the clear liquor poured off. The solubility of lime in water is very remarkable; cold water dissolving more than hot. According to Mr. Phillips,

A pint of Water at 32° dissolves 13·25 grains of lime.
Ditto . . 60°. . . 11·6 ditto.
Ditto . . 212° . . 6·7 ditto.

So that water at 32° dissolves nearly twice as much lime as water at 212°. Lime water is colourless and transparent, but by exposure to the air becomes covered with a film of carbonate of lime, which precipitating to the bottom of the vessel is succeeded by another. Its taste is unpleasant and alkaline, and it has an alkaline reaction on vegetable colours. When a cold saturated solution of lime is heated, small crystals of hydrate of lime are deposited: the same are also produced by evaporating lime water in the exhausted receiver of the air-pump.

Characteristics.—Lime water is recognized by its action on turmeric paper and on the infusion of red cabbage; by the milkiness produced on the addition of carbonic acid or a soluble carbonate, and by the white precipitate on the addition of a solution of oxalic acid or an oxalate. Sulphuric acid affords no precipitate with lime water. Solutions of the alcaneous salts are known by the following characters:—The hydro- sulphures, ferrocyanides, and, if the solution be dilute, the sulphates, occasion neither a precipitate nor a change of colour: the soluble carbonates, phosphates, and oxalates, produce white precipitates. The alcaneous salts (especially chloride of calcium) give an orange tinge to the flame of alcohol.
Composition.—The following is the composition of lime and its hydrate:

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</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>1</td>
<td>20</td>
<td>71'82</td>
<td>71'91</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>28'57</td>
<td>28'69</td>
</tr>
<tr>
<td>Lime</td>
<td>1</td>
<td>28</td>
<td>100'00</td>
<td></td>
</tr>
</tbody>
</table>

Purity.—The lime used in the arts is never absolutely pure, but usually contains variable quantities of carbonaté of lime, silica, alumina, and oxide of iron, and sometimes magnesia.

Physiological Effects. (a.) On vegetables.—Quicklime is poisonous to plants. Notwithstanding this, however, it is sometimes used as manure, its efficacy depending on its decomposing and rendering soluble the vegetable matter of the soil, during which the lime attracts carbonic acid and becomes innocuous. (Davy, *Agricult. Chemistry.*)

(b.) On animals.—On dogs, Orfila (*Toxicol. Gén.*) found that quicklime acted as a caustic poison, but not very energetically; and that it occasions death by producing inflammation of the texture with which it comes in contact.

(c.) On man.—Quicklime is an escharotic. Its chemical action on the tissues is analogous to that of the fixed alkalies, to which must be added its powerful affinity for water. Its use in promoting the decomposition of the bodies of persons who have died of contagious diseases, or on the field of battle, and its employment by the tanner to separate the cuticle and hair from skins, sufficiently establish its causticity. Its escharotic and irritant action is well seen in the ophthalmitis produced by the lodgment of small particles of lime in the eye.

When applied to suppurating or mucous surfaces, lime water checks or stops secretion, and produces dryness of the part: hence it is termed a desiccant.

When administered internally, it neutralizes the free acid of the gastric juice, diminishes the secretions of the gastro-intestinal membrane, and thereby occasions thirst and constipation. It frequently gives rise to uneasiness of stomach, disordered digestion, and not unfrequently to vomiting. After its absorption it increases the secretion of urine, and diminishes the excessive formation or deposition of uric acid and urates. With this exception, it does not, as the alkalies, promote the action of the different secreting organs, but, on the other hand, diminishes it, and has in consequence been termed an astringent. But it does not possess the corrugating action of the astringent vegetables, or of many of the metallic salts: it is rather a drying remedy, and might be more correctly termed a desiccant than astringent. In this respect lime differs from the alkalies, but is analogous to the oxide of zinc. Vogt (*Pharmak.*) considers it to be intermediate between the two. Weickard and others have ascribed to lime an antispasmodic property; and if this be true, its relation to zinc is still further proved.

A power of exciting and changing the mode of action of the absorbent vessels and glands has been ascribed to lime water, and probably with foundation. At any rate, under the use of it, glandular enlargements have become softer and smaller. Sundelin (*Heilmittell.*) says that the excessive use of lime does not, as in the case of the alkalies, bring about a scorbutic diathesis, but a general drying and constriction, analogous to that caused by zinc.
LIME. 345

Lime in large doses acts as a poison: the symptoms in one case were
first, burning in the mouth, burning pain in the belly, obstinate consti-
tion, and death in nine days. (Christison.)

USES.—Quicklime has been employed as a caustic, but alone is now
usually resorted to. It is sometimes applied in the form of potassa cum
water, in conjunction with milk, was recommended by Navier
l'arsenic; &c. 1777, quoted by Richter, ausf. Arzn.) in
poisoning by arsenic acid. In the absence of more appropriate anti-
tics, lime water may be administered in poisoning by the common
acid and oxalic acids. As a lithotrity it possessed at one time
considerable celebrity, partly from its being one of the active ingredients
of Miss Joanna Stephens' Receipt for the Stone and Gravel, as well as in
experiments and reports of professional men. As this lady had
attained no slight fame by her mode of treatment, a great desire was
manifest to know the nature of her remedies, and she therefore offered
her services. The following is a record of the payment of a suitable reward. A committee of
professional men was appointed to examine the efficacy of her treatment,
and her medicines were given to patients known to have calculi. The
report made by the committee, as to the effects, was so favourable, that
a claim was induced to grant a reward of £5000, a notice of which
appeared in the London Gazette of March 18, 1739! (D'Escherny, A
Narrative of the Causes and Symptoms of the Stone, 1755.) The essential
ingredients of her remedies were lime (prepared by calcining egg-shells and
bark), soap, and some aromatic bitters; viz. camomile flowers, sweet fen-
parsley, and burdock leaves, &c. That the patients submitted to treat-
ment obtained relief by the remedies employed cannot, I think, be doubted,
but no cure was effected; that is, no calculus was dissolved, for in the
bladder of each of the four persons whose cure was certified by the
patients, the stone was found after their death (Alston's Lect. on the Mat.
vol. i. p. 268). Notwithstanding the favourable reports to the
library (Chevallier, Med. Gaz. vol. xx. p. 460), it appears to me that
the ground of hope can now be entertained that lime water is
able of dissolving urinary calculi in the kidneys or bladder; but
there is abundant evidence to prove that patients afflicted with the uric
diathesis have sometimes experienced extraordinary benefit from
use (Van Swieten's Commentaries upon Boerhaave's Aphorisms, vol. xvi.
199). Its mode of action is analogous to that of the alkalies (vide
efficacy in the treatment of gravel and stone by the circumstance of the
bination of the lime with uric acid forming a very soluble salt, viz.
the of lime, and he even thinks that lime water may be useful in phos-
phoric calculi, either by depriving them of a portion of the uric acid
which they contain, and thus rendering them less dense; by decomposing
ammoniacal salt which enters into the composition of some; or by
acting on the animal matter which holds the molecules of these calculi
other. As an antacid in dyspepsia accompanied by acidity of stom-
th, it is sometimes useful. "Mixed with an equal measure of milk,
which completely covers its offensive taste, it is one of the best remedies
for possession for nausea and vomiting dependent on irritability of
stomach. We have found a diet, exclusively of lime water and milk, to
be more effectual than any other plan of treatment in dyspepsia, accom-
panied with vomiting of food. In this case one part of the solution of
astringent, the lime water has been serviceable. As a depressant or astringent, it is
useful as a wash for ulcers attended with excessive secretion. In some
scrofulous ulcers in which I have employed it, its power of checking
secretion has been astonishing. In diarrhoea, when the mucous discharg,
has been given as an alterative in glandular enlargements and venereal affec
tions, and to promote the deposit of bone earth in diseases accompanying
with a deficiency of this substance. In skin diseases (tinea capitis, scabies, prurigo, &c.) it has been applied as a wash.

ADMINISTRATION.—From half an ounce to three or four ounces may
be taken three times a day. As already mentioned, it may be conve
niently administered in combination with milk.

Lentimentum Calcis, Ph. Dub. & U. S.; Oleum Lini cum Calce, Ph. Ed. Calcareous soap or oleo-margarate of lime (lime water, linseed or olive oil as equal parts).—This compound has been celebrated as an
application to burns and scalds. From being used at the Carron Iron
works, in cases of burns, it is called Carron oil. It is almost invariably
prepared with linseed oil, though in the Dublin Pharmacopoeia olive oil
is ordered. Turpentine may be sometimes advantageously added to it.

Calcii Chloridum.—Chlor'ide of Calcium.

History.—This salt, obtained in the decomposition of sal ammoni
by lime, was known, according to Dulk (Die Preuss. Pharm. überset.
&c. ii. 293) in the fifteenth century to the two Holland, who called
fixed sal ammoniac (sal ammoniacum fixum). Its composition was not
understood until the eighteenth century, when it was ascertained by
Bergman, Kirwan, and Wenzel. It is commonly termed muriate
lime.

Natural History.—It is found, in small quantity, in sea and mar
mineral and well waters. It has also been detected, in a few instance
in vegetables: thus Pallas recognised it in the root of Aconitum Lyon
tonum.

Preparation.—It is readily prepared by dissolving carbonate of lime
in hydrochloric acid. The proportions ordered in the London Pharma
copoeia are, five ounces of chalk, half a pint of hydrochloric acid, a
the like quantity of water. When the effervescence has finished, the
filtered solution is ordered to be evaporated to dryness, and the resid
REAGENTS. 

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Ure.</th>
</tr>
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<tbody>
<tr>
<td>Calcium</td>
<td>1</td>
<td>20</td>
<td>35·71</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1</td>
<td>36</td>
<td>64·28</td>
</tr>
<tr>
<td>Chloride Calcium</td>
<td>1</td>
<td>56</td>
<td>99·99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride Calcium</td>
<td>1</td>
</tr>
<tr>
<td>Water</td>
<td>6</td>
</tr>
<tr>
<td>Cry Chld Calc</td>
<td>1</td>
</tr>
</tbody>
</table>

 Chloride of calcium is a secondary product in the manufacture of the hydrated sesquicarbonate of ammonia (p. 174).

Properties.—Anhydrous chloride of calcium is a white translucent solid, of a crystalline texture. Its taste is bitter and acrid saline. It is soluble, but not volatile. It deliquesces in the air, and becomes what has been called oil of lime (oleum calcis). When put into water it evolves gas, and readily dissolves in a quarter of its weight of this fluid at 15°C, or in a much less quantity of hot water. By evaporation the solution yields striated crystals (hydrated chloride of calcium), having the form of regular six-sided prisms, and which, therefore, belong to the rhombohedral system (p. 61). These crystals undergo the watery fusion when heated, are deliquescent, readily dissolve in water with the production of great cold, and when mixed with ice or snow form a powerful refrigerating mixture. Both anhydrous and hydrous chloride of calcium are readily soluble in alcohol.

Characteristics.—This salt is known to be a chloride by the tests for this class of salts before mentioned (p. 105). The nature of its base ascertained by the tests for lime (p. 343).

Composition.—The composition of this salt is as follows:

Purity.—Chloride of calcium, when pure, is colourless, evolves no ammonia when mixed with lime, and undergoes no change of colour nor fumes any precipitate with caustic ammonia, chloride of barium, hydrochloric acid, or ferrocyanide of potassium.

Physiological Effects. (a) On animals.—Three drachms and a half given to a dog caused quick breathing and snorting, with convulsive efforts to vomit, a profuse secretion of saliva, and death in six hours. The mucous membrane of the stomach and small intestines was very blood-shot, and in many places almost black, and converted into a gelatinous mass (Beddoes, Duncan's Annals of Medicine, vol. i. Astr. ii. 208).
(b.) On man.—In small doses it promotes the secretions of mucus, urine, and perspiration. By continued use it appears to exercise a specific influence over the lymphatic vessels and glands, the activity of which increases; for under its use glandular and other swellings and indurations have become smaller and softer, and ultimately disappeared altogether. In larger doses it excites nausea, vomiting, and sometimes purging; causes tenderness in the precordium, quickens the pulse, and on occasions faintness, weakness, anxiety, trembling, and giddiness. In excessive doses the disorder of the nervous system is manifested by failure and trembling of the limbs, giddiness, small contracted pupils, cold sweats, convulsions, paralysis, insensibility, and death (Vogt, Pharmacodynam). Considered in reference to other medicines, it has the closest resemblance in its operation to chloride of barium. Hufeland (quote by Wibmer, die Wirkung, &c.) says its operation is more irritant than the last mentioned substance, and that its use requires greater caution,—a statement which is directly opposed to the experience of Dr. Wood (Ed. Med. and Surg. Journ. i. 147), and of most other practitioners.

Uses.—It has been principally employed in scrofulous affections, especially those attended with glandular enlargements. Beddoes (op. cit.) gave it to nearly a hundred patients, and he tells us there are few of the common forms of scrofula in which he has not had successful experience of it. Dr. Wood (op. cit.) tried it on an extensive scale, and with decided benefit. It has been found most efficacious in the treatment of tabes mesenterica, checking purging, diminishing the hectic fever, allowing the inordinate appetite, and ultimately restoring the patient to perfect health. It has also been recommended in chronic arthritis complaints in bronchocele, in some chronic affections of the brain (as paralysis), and in other cases where the object was to excite the action of the absorbents.

Occasionally, though rarely, it has been employed externally. That a bath containing two or three ounces of it, either alone or with chlorides of sodium, has been used in scrofula (Vogt, Pharmacodynam.)

In pharmacy chloride of calcium is used in the rectification of spirit (p. 197), on account of its strong affinity for water. In chemistry it employed in the drying of gases, and in the crystallized state, mixed with half or two-thirds of its weight of ice or snow, for producing an intense degree of cold.

Administration.—Chloride of calcium is always used in the form of aqueous solution. The Liquor Calcii Chloridi, Ph. L. consists of four ounces of the chloride dissolved in twelve fluidounces of distilled water. The dose of it is forty or fifty minims, gradually increased until slight nausea is produced.

Calcis Hypochlo'ris.—Hypochlo'rite of Lime.

History.—In 1798, Mr. Tennant, of Glasgow, took out a patent for the manufacture of this substance as a bleaching powder, which in consequence was long known as Tennant’s bleaching powder. According the views entertained of its composition, it has been successively termed oxymuriate of lime, chloride of lime or chlorornet of the oxide of calcium, chlorite of lime (Berzelius), and chlorinated lime (calc chlorinata, Ph. L.
PREPARATION.—It is prepared by conveying chlorine gas into a vessel chamber containing slacked lime. On the large scale the gas is generated in large, nearly spherical, leaden vessels heated by steam. The reagents employed are binoxide of manganese, chloride of sodium, diluted sulphuric acid. The gas is washed by passing it through water, and is then conveyed by a leaden tube into the combination room, where the slacked lime is placed in shelves or trays, piled over one another to the height of five or six feet, cross bars below each, keeping about an inch asunder, that the gas may have free room to circulate. The combination chamber is built of siliceous sandstone, and is fitted with windows, to allow the operator to judge how the impregnation is going on. Four days are usually required, at the ordinary rate of working, for making good marketable chloride of lime (Ure, Quat. Rev. of Science, xiii. 1). At Mr. Tennant’s manufactory at Glasgow, lime is placed in shallow boxes at the bottom of the combination chambers, and is agitated during the process by iron rakes, the handles of which pass through boxes filled with lime, which serves as a valve (American Journ. of Science, vol. x. No. 2, Feb. 1826, and Dumas’ Traité chimie, ii. 806). The theory of the process will be noticed when describing the composition of this substance.

PROPERTIES.—Chloride of lime, as met with in commerce, is a white, powdery, white powder, having a feeble odour of chlorine, and a strong sweet and acid taste. Exposed to the air it evolves chlorine, and acts on carbonic acid, and is thereby converted into a mixture of carbonate of lime and chloride of calcium, the latter of which deliquesces. Digested water the chloride or hypochlorite of lime dissolves, as well as any chloride of calcium present, and a small portion of caustic lime: any carbonate and the excess of caustic lime remain undissolved. The solution, thus has a slight yellow colour, first reacts on vegetable colours as an oxidizing agent, and afterwards bleaches them. Its bleaching and disinfecting powers depend on the oxidizing power of the solution. If acid be employed in the process, chlorine is evolved, which produces an expense of the elements of water, as before mentioned (107): if, on the contrary, no acid be used, Balard (Researches, in Lord’s Scientific Memoirs, vol. i. p. 269) supposes that both the hypochlorous acid and lime give out their oxygen, and thereby become chlorinated calcium. When chloride of lime is heated it evolves first chlorine, then subsequently oxygen.

CHARACTERISTICS.—Its smell and bleaching properties are most characteristic of it. The acids (as sulphuric or hydrochloric) separate chlorine from it. An aqueous solution of it throws down white precipitates of nitrate of silver, the alkaline carbonates, and with oxalic acid or the oxides. The supernatant liquor from which chloride of silver has been thrown down by nitrate of silver possesses a decolorizing property.

IMPOSITION.—Chemists are not agreed as to the nature of the sub- stance called chloride of lime. By most English chemists (Dalton, Linnon, Brande, Turner, and Phillips), it is supposed that when chlorine in contact with slacked lime combination takes place, and that chlorine undergoes no decomposition. By others (Berzelius, Soubrié, Balard), however, it is supposed that part of the lime is decomposed; a portion of the chlorine uniting with the calcium to form chloride of lime; and another with the oxygen to become hypochlorous (chlorous,
Berzelius) acid, which combines with the undecomposed lime: so that the so-called chloride of lime is, according to this view, a mixture of chlorid of calcium and hypochlorite (or rather a tris-hypochlorite) of lime an water. The following diagram illustrates the formation of these compounds according to the latter theory:

When chloride of lime comes in contact with water, the tris-hypochlorites deposits two equivalents of hydrate of lime, while one equivalent of the chloride of calcium and one equivalent of the neutral hypochlorite lime are dissolved.

The following table shews the composition of the so-called chloride lime according to Soubeiran (Now. Traité de Pharm. ii. 365); Phillip (Transl. 3d ed.); and Ure, (op. cit.)

**Chlorometry** — The chloride of lime of commerce varies in the quantity of hypochlorite which it contains, and hence some chlorometric process is necessary in order to ascertain its goodness. The two principal methods are, to determine the quantity of chlorine gas which evolves on the addition of hydrochloric acid (Ure, Quart. Journ. of Science, xiii. 21) and to observe what quantity of sulphate of indigo it capable of decolorizing (Gay Lussac, in Alcock’s Essay, p. 136.) Ure says 10 grains of good bleaching powder should yield 3 or 4 inchies of chlorine.

**Physiological Effects.**—The effects of chloride (hypochlorite) of lime on the system have not as yet been accurately ascertained. local action is that of an irritant and caustic. A solution of it applied suppurating and mucous surfaces is a powerful desiccent, probably part at least from the uncombined lime in solution. When the secretion are excessive and extremely fetid, it not only diminishes their quantity but much improves their quality; so that considered in reference to suppurating and mucous surfaces, it is not only a desiccent, but, in most conditions of these parts, a promoter of healthy secretion. Applied the form of ointment (composed of a drachm of chloride to an ounce fatty matter) to scrofulous swellings, Cima (Configliachi and Brugnato, Giornale di Fisica, 1825, quoted by Dierbach, d. newst. Entf. in d. M. Med. 1828, 2nd. Abt. 597), found that it provoked suppurating, caused strong redness, promoted the suppurating process, and dispersed the surrounding hardness.

Taken internally in small doses (as from 3 to 6 grains dissolved in or two ounces of water) it sometimes causes pain and heat in the stoma...
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fractures accompanied with offensive discharges, to the uterus in various
diseases of this viscera attended with fetid evacuations; in a word, we
apply them in all cases accompanied with offensive and fetid odours.
As I have before remarked with respect to chloride of soda (p. 316) their
efficacy is not confined to an action on dead parts, or on the discharge
from wounds and ulcers: they are of the greatest benefit to living parts,
in which they induce more healthy action, and the consequent secretion
of less offensive matters. Furthermore, in the sick chamber, many other
occasions present themselves on which the power of the chlorides
will be found of the highest value: as to counteract the unpleasant smell of dressings or bandages, of the urine in various dis-
eases of the bladder, of the alvine evacuations, &c. In typhus fever,
handkerchief dipped in a weak solution of an alkaline chloride, and sus-
pended in the sick chamber, will be often of considerable service both to
the patient and the attendants.

The power of the chlorides (hypochlorites) to destroy infection and
contagion, and to prevent the propagation of epidemic diseases, is
less obviously and satisfactorily ascertained than their capability of
destroying odour. Various statements have been made by Labarrage
and others (vide Alcock's Essay, p. 55, et seq.) in order to prove th
disinfecting power of the chlorides with respect to typhus and other
infectious fevers. But, without denying the utility of these agents in
destroying bad smells in the sick chamber, and in promoting the recov-
ery of the patient by their influence over the general system, I may
observe that I have met with no facts which are satisfactory to my mind
as to the chemical powers of the chlorides to destroy the infectious ma-
ter of fever. Nor am I convinced by the experiments made by Paris
and his colleagues (Bulletin des Sciences Méd. xix. 233) that these med-
cines are preservative against the plague. Six individuals clothed them-
selves with impunity in the garments of men who had died of plague
but which garments had been plunged for six hours in a solution of
chloride of soda. But, as Bouillaud (Dict. de Méd. Prat., art. Contag-
gion) has truly observed, the experiments, to be decisive, should have
been made with clothing which had already communicated the plague
to the wearers of it. In Moscow, chlorine was extensively tried and found
unavailing, nay, apparently injurious, in cholera. "At the time," sa
Dr. Albers (Lond. Med. Gaz. viii. 410) "that the cholera hospital was
filled with clouds of chlorine, then it was that the greatest number of the
attendants were attacked." (See also Dierbach, d. neust. Entl. in d. Med.
ii. 411, 2te Ausg. 1837.) Some years ago chlorine was tried at the
Small Pox Hospital, with a view of arresting the progress of erysipelas
all offensive smell, as usual, was overcome, but the power of commu-
nicating the disease remained behind. (Lond. Med. Gaz. viii. 472.) Bou-
quoy (Rev. Méd. Fev. 1830, p. 264) mixed equal parts of a solution
chloride of soda and the vaccine lymph, and found that the latter still possessed the power of producing the usual cow-pox vesicle. These are
a few of the facts which are adverse to the opinion that chlorine or the
chlorurets possess the power of preventing the propagation of infectious
contagious, or epidemic diseases. In opposition to them there are but few
positive facts to be adduced. Coster (Richter, Auf. Arzneimittell. Suppl.
Band. 539) found that a solution of chloride of soda destroyed the infective
properties of the syphilitic poison, and of the poison of rabid anima
sor statements of Labarraque (Alcock’s Essay, pp. 56, 58, &c.) and ders as to the preservative powers of the chlorides in typhus, measles, are too loose and general to enable us to attach much value to m.

Considered in reference to medical police, the power of the alkaline orides (hypochlorites) to destroy putrid odours and prevent putrefaction is of vast importance. Thus chloride of lime may be employed to pent the putrefaction of corpses previously to interment, to destroy the ur of exhumed bodies during medico-legal investigations, to destroy smells, and prevent putrefaction in dissecting-rooms and workshops which animal substances are employed (as cat-gut manufactories), to troy the unpleasant odour from privies, sewers, drains, wells, docks, , to disinfect ships, hospitals, prisons, stables, &c. The various modes applying it will readily suggest themselves. For disinfecting corpses, et should be soaked in a pailful of water containing a pound of oride, and then wrapped around the body. For destroying the smell dissecting-rooms, &c. a solution of the chloride may be applied by a of a garden watering-pot. When it is considered desirable to e the rapid evolution of chlorine gas, hydrochloric acid may be added chloride of lime.

Chloride of lime (or chloride of soda) is the best antidote in poisoning atrosulphuric acid, hydrosulphuret of ammonia, sulphuret of potas-., and hydrocyanic acid. It decomposes and renders them inert. A uation should be administered by the stomach, and a sponge or hand-thief soaked in the solution, held near the nose, so that the vapour be inspired. It was by breathing air impregnated with the vapour ring from chloride of lime that Mr. Roberts (the inventor of the miner’s roved safety lamp), was enabled to enter and traverse with safety the er of the Bastile, which had not been cleansed for 37 years, and ch was impregnated with hydrosulphuric acid. (Alcock’s Essay.) If aer be required to enter a place suspected of containing hydrosul-ric acid, a handkerchief moistened with a solution of chloride of lime ill be applied to the mouth and nostrils, so that the inspired air may purified before it passes into the lungs.

Solutions of chloride of lime have been used as a wash in some skin cases. Derheimus (Journ. Chim. Méd. iii. 575) used a strong solution great success in scabies. This mode of curing itch is much cleaner, more agreeable, than the ordinary method by sulphur frictions. has likewise been found successful by Fantonetti (Journ. de a. Méd. ix. 305) in linea capitis: where the discharge is co., washes of the chloride may be used with advantage. In burns scalds Lisfranc employed lotions of chloride of lime either immen- after the accident, or subsequent to the application of emol-oultries.

Solutions of chloride of lime have been employed with great benefit in halma. Dr. varlez, surgeon to the military hospital at Brussels, l. and Phys. Journ. Nov. 1827) states that in 400 cases it never dis-inted him once. Mr. Guthrie has also reported favourably of it in cases; as have likewise MM. Colson, Delatte, and Raynand. The ion used by Dr. Varlez was composed of from a scruple to three or drachms of chloride, and an ounce of water. It was dropped into
the eye or injected by a syringe, or applied by means of a camel's hair pencil. Of course other means (bleeding, purging, cold, and, in chronic cases, blisters) should be conjoined. I have found a weak solution of the chloride very successful in the purulent ophthalmia of infants. Gubian (Journ. de Chim. Méd. vi. 315) proposed to apply a solution of chloride of lime to prevent the pitting from small-pox. The fully maturated pustules are to be opened and washed with a weak solution of this salt; desiccation takes place very promptly, and no marks or pits are said to be left behind.

Chloride of lime may be employed internally in the same cases that chloride of soda is administered (p. 316.) It has been used with great success by Dr. Reid (Trans. of the King and Queen's College of Physicians in Ireland, v. 266) in the epidemic fever of Ireland. In some of the very worst cases it acted most beneficially, causing warm perspiration, rendering the tongue cleaner and moister, checking diarrhœa, and inducing quiet sleep. I also can bear testimony to the good effects of the remedy in bad cases of fever. In disease of the pulmonary organs resulting from febrile excitement, Dr. Reid also found it advantageous. In dysentery likewise it was most valuable. He used it by the mouth as also in the form of glyster. It corrected the intolerable stench of the evacuations, and improved their appearance. Cima (Richter, Arzneimitt. iv. 305) used it both internally and externally in scrofula.

ADMINISTRATION.—Internally, chloride of lime may be given in dose of from one grain to five or six grains, dissolved in one or two ounces water, sweetened with syrup. As the dry chloride of the shops deposes hydrate of lime when put into water, the solution (of the hypochlorite of lime and chloride of calcium) should be filtered, to get rid of this. To destroy the unpleasant smell of the breath, lozenges of chloride of lime have been used. (Journ. de Chim. Méd. iii. 496.)

For external use (lotions and gargles) it is also generally employed; the form of solution, the strength of which must vary according to the quality of the chloride, and the nature and seat of the disease to which we intend to apply it. The average proportions are from one to five drachms of chloride to a pint of water. In the cure of itch, Derheim employed a wash composed of three ounces of chloride to a pint of water. The solution is to be filtered to separate the hydrate of lime. Cima employed an ointment of chloride of lime (composed of from a scruple to a drachm of chloride, and an ounce of fresh butter) by way of friction, to reduce scrofulous enlargements of the lymphatic glands which had resisted the use of mercurial ointment. When the evacuations from the bowels are very offensive, chloride of lime may be used in the form of enema. For this purpose, ten or fifteen grains or more may be added to the common enema.

ANTIDOTES.—Administer albuminous liquids (as eggs beat up with water) or milk, or flour and water, or oil, or emulgent drinks, to excite vomiting; combat the gastro-enteritis by the usual means. Carefully avoid the use of acids, which would cause the evolution of chlorine gas in the stomach.
**Calcis Carbonate.**—*Carbonate of Lime.*

**History.**—Some varieties of carbonate of lime were distinguished and employed in the most remote periods of antiquity. Marble was probably used for building 1050 years before Christ (1 Chron. xxix. 2.) Iny (Hist. Nat. xxxvi.) tells us that Dicerus and Scyllis were renowned as statuaries of marble in the 50th Olympiad (i.e. 557 years before Christ.) The creta, mentioned by Horace (Sat. iii. lib. 2), and Iny (Hist. Nat. xxxvi. 58, Valp. ed.), was probably identical with our ilk. (On the chalk of the ancients, consult Beckmann's Hist. of Inst. i. 212.)

**Natural History.**—Carbonate of lime occurs in both kingdoms of nature.

(a) **In the inorganized kingdom.**—It forms a considerable portion of a known crust of the earth, and occurs in rocks of various ages. It is found in the inferior stratified rocks, but more abundantly in the different clays of the fossiliferous rocks, particularly towards the central and other parts of the series (De la Beche, Researches in Theoretical Geology, 21.)

In the crystallized form it constitutes calcareous spar and aragonite. Of these, only the first is most extensively distributed, and presents itself under many hundred varieties of shapes, the primitive form of all being the trapezohedron.

Granular carbonate of lime (the granular limestone of mineralogists) is commonly found in beds, but sometimes constitutes entire mountains. The whitest and most esteemed primitive limestone is that called travertine marble, or, from its resemblance to white sugar, saccharoid carbonate of lime. That from Carrara, on the eastern coast of the Gulf of Poona, is the kind usually employed by the statuary, and being very fine, may be employed for pharmaceutical purposes.

Chalk constitutes the newest of the secondary rocks, and occurs abundantly in the southern parts of England. It lies in beds, and contains abundance of marine as well as terrestrial organic remains. The upper part of a considerable portion of the chalk of England contains numerous flints, which are supposed by some (Dr. Grant, Lect. on Comp. Anat. the Lancet, Nov. 2, 1833) to have once belonged to poriferous animals.

There are various other native forms of carbonate of lime constituting substances called by the mineralogist schief er spar, rock milk, earth milk, stalactitic carbonate of lime, anthracite milk, oolite, pisolite, marl, &c.

Carbonate of lime is an ordinary ingredient in mineral and common waters, being held in solution by carbonic acid, and, therefore, deposited when this is expelled by boiling or otherwise.

(b) **In the organized kingdom.**—Carbonate of lime is a constituent of the plants, and is obtained from the ashes of most. It is an abundant constituent of animals, especially of the lower classes. Thus in the invertebrate animals we find it in the hard parts of corals, madrepores, &c.; the molluscs, in the shells (as in the oyster). In the articulated animals it forms, with phosphate of lime, the crusts which envelop these
animals (as the crab and lobster); in the higher classes it is found in bone, but the quantity of it is very small.

Preparation.—In the Dublin Pharmacopoeia, carbonate of lime (calcis carbonas præcipitatum, Ph. D.) is ordered to be prepared by adding a solution of carbonate of soda to a solution of chloride of calcium: double decomposition takes place, chloride of sodium is formed in solution, and carbonate of lime precipitated. Thus prepared, carbonate of lime is directed to be used in the preparation of hydrargyrum cæm cretă. By some druggists it is employed, instead of prepared chalk, in the manufacture of aromatic confection.

Marble (marmor, Ph. L., marmor album, Ph. D. & Ed.), or hard carbonate of lime (carbonas calcis durus, Ph. L.) is employed for the production of carbonic acid (vide p. 190); and, in some Pharmacopoeias, for the preparation of chloride of calcium. For the latter purpose, especially, white or statuary marble should be selected, on account of its freedom from iron.

Chalk (creta, Ph. L., creta alba, Ph. Dub. & Ed.) or friable carbonate of lime (calcis carbonas friabilis, Ph. L., carbonas calcis mollior, Ph. Ed.) is found in great abundance in the southern parts of England. To reduce it to a fine state of division, and to deprive it of its coarser parts, it is submitted to the process of elutriation, and is then called prepared chalk (creta preparata, Ph. L. & Dub., carbonas calcis preparatus, Ph. Ed. & U. S.)

Carbonate of lime is prepared, for medical purposes, from several molluscous animals; as from the shell of the oyster (Ostrea edulis), the gastric concretions (called crabs' eyes or stones) of the crayfish (Astacæ fluviatilis), and the crustaceous envelope of the claws of the crab (Cancer pagurus). The carbonate procured from these sources is called, respectively, testæ præparate (Ph. L.), lapilli cancerorum, and chela cancerorum and will be described in a subsequent part of this work (vide Animal Materia Medica).

Properties.—Pure carbonate of lime is a tasteless, odourless solid. When heated to redness in a current of air its carbonic acid is expelled, leaving quicklime. It is almost insoluble in water; one part of carbonate requiring 1600 parts of water to dissolve it. It is much more soluble in carbonic acid water: the solution reddens litmus, but changes the yellow colour of turmeric paper to brown; and by boiling, or exposure to the air, gives out its carbonic acid, by which the carbonate of lime is deposited.

Carbonate of lime is a dimorphous substance; that is, it crystallizes in two distinct and incompatible series of forms,—viz. those of the rhombohedric system (calcareous spar), and those of the right rectangular prismatic system (arragonite). According to Gustav Rose (Lond. & Ed. Phil. Mag. June 1838), both calcareous spar and arragonite may be formed in the humid way, but the first at a lower, the latter at a higher temperature: in the dry way, calcareous spar alone is formed. Both minerals doubly refract the rays of light, and expand unequally in the different parts when heated; but calcareous spar has only one axis of double refraction, whereas arragonite has two.
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**Fig. 54.**

A single system of rings seen by looking through a slice of calcareous spar (cut perpendicular to the axis of the crystal) placed between two plates of tourmaline (cut parallel to the axis of the crystal).

**Fig. 55.**

54 is seen when the plane of the axis of the calcareous spar is parallel or perpendicular to the plane of polarization. Fig. 55 is seen when the calcareous spar is turned 45°.

Granular limestone (of which white marble is the purest kind) is massive, and consists of small grains or minute crystals, presenting a lamellar fracture and brilliant lustre, but intersecting each other in every direction, and thereby giving a glimmering lustre to the mass.

Chalk is massive, opaque when pure white, and has an earthy fracture. It is usually soft to the touch, and adheres to the tongue.

**CHARACTERISTICS.**—Carbonate of lime is recognized as a carbonate the tests already mentioned for this class of salts (p. 191). As a carbonate salt it is known by the characters before described (p. 343) for

**COMPOSITION.**—Carbonate of lime has the following composition:

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**SOLUBILITY.**—Pure marble or chalk should be perfectly soluble, with effervescence, in hydrochloric acid, by which the absence of silica is shown. Ammonia should not cause any precipitate with this solution, by which freedom from alumina, oxide of iron, &c. may be inferred: nor should solution of sulphate of lime throw down any thing by which the presence of baryta and strontian is proved.

**PHYSIOLOGICAL EFFECTS.**—The local effects of chalk are those of an antacid, and mild desiccant. When swallowed it neutralizes the free acid of the gastric juice, and in this way alone must, by continuing, injure the digestive functions. It causes constipation, an effect usually observed from the use of a few doses in diarrhoea. By the action of the free acids (acetic and hydrochloric) of the alimentary canal, it is converted into two soluble calcareous salts (acetate of lime and carbonate of calcium), which become absorbed. Hence the continued use of carbonate of lime is attended with the constitutional effects of the calcareous salts, and consequently the statements which have been made to the influence of chalk over the lymphatic vessels and glands, and
its effect in diminishing excessive secretion, may be correct. Sundel (Heilmittellehre, i. 179) thinks it may even promote the deposit of bone-earth in diseases attended with a deficiency of this substance. Carbonate of lime, prepared from animal matter, has been erroneously supposed to be more digestible than chalk, and therefore less likely to occasion dyspeptic symptoms (Wibner, die Wirkung, &c. ii. 10).

Dr. A. T. Thomson (Elements of Materia Medica, ii. 82) says, that “after chalk has been used for some time, the bowels should be cleared out, as it is apt to form into hard balls, and to lodge in the folds of the intestines.”

Uses.—As an absorbent and desiccant, prepared chalk is used as a dusting powder in moist excoriations, ulcers, the intertrigo of children, burns and scalds, erysipelatous inflammation, &c.

As an antacid it is exhibited in those forms of dyspepsia accompanied with excessive secretion of acid; and as an antidote in poisoning by the mineral and oxalic acids.

It has also been used in some diseases which have been supposed to depend on, or be accompanied by, excess of acid in the system—as in gouty affections, which are usually attended with the excessive production of uric acid, and in rachitis, which some have ascribed to a preponderance of phosphoric acid, or to a deficiency of lime in the system.

To diminish alvine evacuations, it is employed in diarrhoea. Its efficacy can hardly be referred solely to its antacid properties; for other antacids are not equally successful. Moreover, in many cases of diarrhoea in which chalk is serviceable, no excess of acidity can be shown to exist in the bowels. Aromatics are useful adjuncts to chalk in most forms of diarrhoea. In old obstinate cases, astringents (as catechu or kino) may be conjoined with great advantage; and in severe cases, accompanied with griping pains, opium.

Administration.—Prepared chalk is given in the form of powder or mixture, in doses of from ten grains to one or two drachms. It enters into a considerable number of officinal preparations.

1. Mistura Cretæ, Ph. L. & Dub.; Potio Carbonatis Calcis, Ph. Ed. Mistura Calcis Carbonatis, Ph. U. S. (Prepared chalk, 5ss.; sugar, 3ij.; mixture of acacia, l.3ss.; cinnamon water, 5xviii. Ph. L.) In the other Pharmacopeias the proportions are somewhat different. This is a very convenient form for the exhibition of chalk, and is in common use in diarrhoea. Aromatics (as the aromatic confection), astringents (as kino or catechu), or narcotics (as opium), are frequently combined with it. The dose is from one to three table-spoonfuls.

2. Pulvis Creta Compositus, Ph. L. & Dub. (Prepared chalk, 3ss.; cinnamon, 5iv.; tormentil and acacia, Æa. 5ij.; long pepper, 5ss.)—This preparation is aromatic and astringent, and is used in diarrhoea. The dose is from 10 to 20 grains. The pulvis carbonatis calcis compositi (Ph. Ed.) consists of chalk flavoured with nutmegs and cinnamon.

3. Confectio Aromatica, Ph. L. & Dub. (Prepared chalk, 3xvi.; cinnamon and nutmegs, Æa. 5ij.; cloves, 5j; cardamoms, 3ss.; saffron, 5j [water, 1bj., Ph. D.]) The London College order the water to be added when the preparation is used, in order to avoid fermentation, to which this compound is subject. Druggists sometimes substitute a strong infusion of saffron instead of the solid saffron here ordered; and those who are desirous of producing a very fine preparation, employ precipitated carbonate of lime instead of chalk. This preparation possesses the
Phosphate of Lime.

History.—Scheele, in 1769, discovered phosphate of lime in bones.

Natural History.—Phosphate of lime is found in both kingdoms of life.

a) In the inorganized kingdom.—It is a constituent of the mineral Apatite, and of some mineral waters; as those of Karlsbad and Frantzensbrunn, near Eger.

b) In the organized kingdom.—It has been found in some plants, and more frequently and copiously in animals. Thus it constitutes the principal part of the earthen matter of the bones of the vertebrata, and portion of the crusts of the articulata.

Preparation.—Phosphoric acid combines with lime in several proportions, forming basic, neutral, and acid salts. The compound used in medicine is a sub- or \( \frac{3}{4} \) phosphate of lime. When obtained by calcining bones in an open vessel, it is called earth of bones (terra ossium); bone-ash (ossa ustia usta; o. devusta; o. albedinem usta; o. calcinata; dian album), and contains some carbonate of lime and other matter mixed with it. If bone-ash be digested in diluted hydrochloric acid, and caustic ammonia added to the filtered solution, phosphate of lime, free from carbonate, is thrown down in a very minute state of division, and when washed and dried, it constitutes the precipitated phosphate of lime (calcis phosphas precipitatum) of the Dublin Pharmacopoeia. When the horns (cornua) of the deer (cervus) are calcined in an open vessel until they become perfectly white, and the residual ash (phosphate of lime) prepared by elutriation (as creta preparata) obtain burnt hartshorn (cornu ustum, Ph. L.; cornu ustum preparatum).

Properties.—Subsesquiphosphate of lime is white, tasteless, odourless, insoluble in water, but soluble in nitric, hydrochloric, and acetic acids, from which solutions it is thrown down unchanged, in composition, ammonia, potash, and their carbonates. When exposed to a very gentle heat, it fuses, and undergoes no other change. The primary crystallized prism of the crystals of apatite (native subsesquiphosphate of lime) is the natural prism.

Characteristics.—It is known to be a phosphate by its solubility in rochlic acid, and its being again thrown down as a white precipitate when the acid solution is supersaturated with caustic ammonia. It be digested in a mixture of sulphuric acid and alcohol, sulphate of lime is precipitated, and an alcoholic solution of phosphoric acid is formed. The acid may then be recognised by the tests for it already mentioned (p. 253). If the precipitated sulphate of lime be dissolved in water, the solution may be known to contain lime by the tests before described for the calcareous salts (p. 343). The subsesquiphosphate of lime of bones is distinguished from the neutral phosphate by its fusing with greater difficulty, and dissolving more readily in hydrochloric acid. A very delicate test of the neutral phosphate is its crystallizing from rochlic acid by evaporation (Wollaston, Phil. Trans. for 1797, 196 & 397).
Composition.—The composition of subsesquiphosphate of lime is as follows:

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<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
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<tbody>
<tr>
<td>Lime</td>
<td>1/6</td>
<td>42</td>
<td>53.85</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>1</td>
<td>36</td>
<td>46.15</td>
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</table>

Subsesquiphosphate of Lime I | 78 | 100.00 | 100.00 | 100.00 | 100.00 |

Bone-ash obtained from the bones of the ox consists of subsesquiphosphate of lime, carbonate of lime, phosphate of magnesia, and a trace of fluoride of calcium.

Physiological Effects.—Its effects are not very obvious. "As phosphate of lime is very difficultly soluble," observes Wibmer (die Wirkung &c. ii. 9), "it is absorbed in small quantity only, and then acts more or less like lime, as a slight astringent on the tissues and the secretions, and increases, incontestibly, the presence of calcareous salts in the bones of the blood, and the urine. Large doses disorder the stomach and digestion by their difficult solubility."

Uses.—It has been administered in rickets, with the view of promoting the deposition of bone-earth in the bones. The sesquioxide of iron may be advantageously conjoined with it.

Administration.—The dose of subsesquiphosphate of lime is from ten grains to half a drachm. For internal use the preparation of the Dublin College is to be preferred.


Magnesia.—Magnesia.

History.—It was first chemically distinguished from lime in 1755, by Dr. Black, who also shewed the difference between magnesia and its carbonate. From the mode of procuring it, it is frequently termed calcined or burnt magnesia (magnesia calcinata seu usta.) It is sometime called t alc earth (Talkerde), or bitter earth (Bittersalzerde.)

Natural History.—It occurs in both kingdoms of nature.

(a.) In the inorganic kingdom.—Magnesia is found native, in the solid state or in solution, in sea or some mineral waters, in combination with water and various acids (carbonic, sulphuric, boracic, silicic, and nitric.) Chloride of magnesium exists in sea water, as also in some springs.

(b.) In the organized kingdom.—Combined with acids it is found in some vegetables (as Salsola Kali and Fucus vesiculosus), and animals (as in the urine and some urinary calculi of man.)

Preparation.—Magnesia is obtained by exposing the subcarbonate to a full red heat for two hours in a crucible, so as to drive off the carbonic acid.

Properties.—It is a light, fine, white, colourless, odourless, and tasteless powder, having a sp. gr. 2.3. When moistened with water it reacts as an alkali on test papers. It is very slightly soluble in water and like lime is more soluble in cold than in hot water. Dr. Fyffe states that it requires 5142 parts of cold, and 36000 parts of hot water to dissolve it. Unlike lime it evolves scarcely any heat when mixed with water. By the combined voltaic and oxy-hydrogen flames it has been fused by Mr. Brande (Manual of Chemistry.) It absorbs carbonic acid slowly from the atmosphere.
CHARACTERISTICS.—It is soluble in the dilute mineral acids without effervescence. The solution does not occasion any precipitate with the cyanides, hydrosulphurets, oxalates, or bicarbonates. The neutral salie carbonates, when unmixed with any bicarbonate, throw down a white precipitate. Ammonia with phosphate of soda causes a white precipitate (ammoniacal-phosphate of magnesia.) Magnesia is insoluble in alkaline solutions, and is thereby distinguished from alumina. Its solution in sulphuric acid is remarkable for its great bitterness.

COMPOSITION.—Magnesia has the following composition:

<table>
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</thead>
<tbody>
<tr>
<td>nesium</td>
<td>1</td>
<td>12</td>
<td>60</td>
<td>59-3</td>
<td>59-5</td>
</tr>
<tr>
<td>gen</td>
<td>1</td>
<td>8</td>
<td>40</td>
<td>40-7</td>
<td>40-5</td>
</tr>
<tr>
<td>nesia</td>
<td>1</td>
<td>20</td>
<td>100</td>
<td>100-0</td>
<td>100-0</td>
</tr>
</tbody>
</table>

PURITY.—Its freedom from any carbonate is shewn by its dissolving in dilute mineral acids without effervescence. Its hydrochloric solution would occasion no precipitate with the oxalates, bicarbonates, and acylic salts, by which the absence of lime and sulphates may be inferred.

PHYSIOLOGICAL EFFECTS.—When taken into the stomach, magnesia neutralizes the free acids contained in the stomach and intestines, and forms therewith soluble magnesian salts. In full doses it acts as a laxative; but as it occasions very little serious discharge, Dr. Paris (Pharmalogia, vol. i. art. Cathartics) ranks it among purgatives “which urge the bowels to evacuate their contents by an imperceptible action upon the muscular fibres.” Part of its laxative effect probably depends on the formation of the soluble magnesian salts (chloride of magnesium and acetate of magnesia) which it forms by union with the acids of the alimentary canal. Magnesia exercises an influence over the urine analogous to that of the alkalies, namely, it diminishes the quantity of uric acid in the urine, and when continued for too long a period occasions the deposit of earthy phosphates in the form of white sand. (W. T. Brande, Phil. Trans. 1810, p. 136; and 1813, p. 213.) On account of its greater insolubility, it requires a longer time to produce these effects than the alkalies. When taken in too large quantities and for a long period it has sometimes accumulated in the bowels to an enormous extent, and being irritated by the mucus of the bowels, created unpleasant effects. A boy took every night during two years and a half, from one to two teacupsfuls of Henry’s calcined magnesia (in all between 9 and 10 lbs. troy) in a nephritic attack, accompanied with the passage of gravel; subsequently she became sensible of a tenderness in the left side just above the ribs, connected with a deep-seated tumor, obscurely to be felt on pressure, and subject to attacks of constipation, with painful spasmodic action the bowels, tenesms, and a highly irritable state of stomach. During the attacks she evacuated two pints of “sand,” and on another occasion voided soft light brown lumps, which were found to consist entirely of subcarbonate of magnesia concreted by the mucus of the bowels, in the proportion of 40 per cent. In another case a mass of a similar description, weighing from 4 to 6 lbs., was found imbedded in the head of the colon, six months after the patient had ceased to employ any magnesia. (E. Brande, Quart. Journ. of Science, i. 297.)

USES.—As an antacid it is as efficacious as the alkalies, while it has an
advantage over them in being less irritant, and thereby is not so apt to occasion disorder of the digestive organs. It may be employed to neutralize acids introduced into the stomach from without, (as in cases of poisoning by the mineral acids) or to prevent the excessive formation of, or to neutralize when formed, acid in the animal economy. Thus it is administered to relieve heartburn arising from, or connected with, the secretion of an abnormal quantity of acid by the stomach: its efficacy is best seen in persons of a gouty or rheumatic diathesis, in which the urine contains excess of uric acid. It often relieves the headache to which such individuals are not unfrequently subject. It is most efficacious in diminishing the quantity of uric acid in the urine, in calculous complaints, and according to Mr. Brande (Phil. Trans. 1813, p. 213) it is sometimes effectual where the alkalies have failed. It will be found of great value in those urinary affections in which alkaline remedies are indicated, but in which potash and soda have created dyspeptic symptoms.

As a laxative, magnesia is much employed in the treatment of the diseases of children. It is tasteless, mild in its operation, and antacid,—qualities which render it most valuable as an infant's purgative. Independently of these, Hufeland ascribes to it a specific property of diminishing gastro-intestinal irritation by a directly sedative influence. In flatulency it is combined with some carminative water (dill or anise); in diarrhœa, with rhubarb. It is employed as a purgative by adults in dyspeptic cases—in affections of the rectum, as piles and stricture—an in diarrhœa. It is associated with the carminative waters—with some neutral salts, as sulphate of magnesia, to increase its cathartic operation—or in diarrhœa, with rhubarb.

Administration.—As a purgative, the dose, for adults, is from a scruple to a dram; for infants, from two to ten grains. As an antacid, the dose is from ten to thirty grains twice a day. It may be conveniently given in milk. It is sometimes administered in combination with lemon juice: the citrate of magnesia thus formed acts as a pleasant and mild aperient.

Magnesiaæ Subcar’bonas.—Subcar’bonate of Magnesia.

History.—Subcarbonate of magnesia, also called magnesia alba and carbonate of magnesia, was exposed for sale at Rome at the commencement of the 18th century, by Count di Palma, in consequence of which it was termed Comitisse Palmae pulvis. In 1707, Valentini informed the public how it might be prepared.

Natural History.—Neutral carbonate of magnesia is found native in various parts of Europe, Asia, and America. It constitutes a range of low hills in Hindostan, from whence it has sometimes been imported in considerable quantities into this country, but has been found, as I am informed, unsaleable here. The samples offered for sale about two years since consisted of reniform, opaque, dull masses, adherent to the tongue, having a conchoidal fracture, and considerable hardness. Internally, they were whitish; externally, greyish or yellowish white. The same substance was brought over about a year ago in the calcined state and was nearly white. It was called calcined Indian magnesia. Carbonate of magnesia is found in some mineral waters.
SUBCARBONATE OF MAGNESIA.

Preparation.—Subcarbonate of magnesia is prepared by mixing solutions of sulphate of magnesia (or chloride of magnesium) and carbonate of soda (or carbonate of potash). The directions of the London Pharmacopoeia are as follows:—Dissolve separately four pounds of sulphate of magnesia, and four pounds and eight ounces of carbonate of soda, in one gallon of water, and strain: then mix the liquors, and boil for a quarter of an hour, constantly stirring with a spatula: lastly, having set off the liquor, wash the precipitated powder with boiling distilled water, and dry it.

Two kinds of subcarbonate of magnesia are known and kept in the shops, the light and the heavy. Heavy magnesia (magnesia ponderosa of the shops) is thus prepared:—Add one volume of a cold saturated solution of carbonate of soda to a boiling mixture of one volume of a saturated solution of sulphate of magnesia, and three volumes of water. Boil till effervescence has ceased, constantly stirring with a spatula. Then add with boiling water, set aside, pour off the supernatant liquor, and mix the precipitate with hot water on a linen cloth: afterwards dry it in an iron pot. Light magnesia (magnesia of the shops) is prepared by employing dilute solutions of the sulphate of magnesia and carbonate of soda. If no heat be used, it is apt to be gritty. A heavy gritty magnesia is prepared by separately dissolving 12 parts of the sulphate of magnesia and 13 parts of crystallized carbonate of soda in as little a quantity of water as possible, mixing the hot solutions, and washing the precipitate.

The theory of the process is as follows:—When sulphate of magnesia carbonate of soda are mixed, double decomposition takes place: the chloric acid combines with the soda to form sulphate of soda, and the carbonic acid with the magnesia. The neutral carbonate of magnesia, which we presume to be first formed, is immediately resolved by the water into a subcarbonate, which, with some water, precipitates, and the carbonate which remains is dissolved in the cold liquid. 5 eq. of the neutral carbonate, with 4 eq. of water, produce 1 eq. of bicarbonate; while the 4 eq. of magnesia, 3 eq. of carbonic acid, and 4 eq. of water, precipitate. If we mix the boiling solutions together, 4 eq. of the neutral carbonate give out 1 eq. of free carbonic acid, and a precipitate is formed consisting of 4 eq. of magnesia, 3 eq. of carbonic acid, and 4 eq. of water. This precipitate in both of these cases constitutes the subcarbonate of magnesia of the shops.

Properties.—Subcarbonate of magnesia, as usually met with, is in form of a white, inodorous, and tasteless powder. The light variety falls as a very fine light powder, or in large rectangular masses with rounded edges, or in smaller cubical cakes. The heavy carbonate is, as name indicates, of greater specific gravity than the light. Both kinds softened with water have a feebly alkaline reaction on test paper, but when boiled in water do not communicate this property to water. Subcarbonate of magnesia is nearly insoluble in water: it readily dissolves in carbonic acid water.

Characteristics.—It is distinguished from caustic or calcined magnesia by the effervescence which takes place on the addition of a dilute acetic acid. Its other characteristics are the same as for the latter substance (vide p. 361.)
Composition.—The following is the composition of subcarbonate magnesia of the shops:—

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<td></td>
<td>Eq.</td>
<td>Eq.</td>
<td>Eq.</td>
<td>Eq.</td>
<td>Eq.</td>
<td>Eq.</td>
</tr>
<tr>
<td>Magnesia</td>
<td>45</td>
<td>45</td>
<td>40</td>
<td>33</td>
<td>42</td>
<td>41-50 to 43 2</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>34</td>
<td>25</td>
<td>33</td>
<td>32</td>
<td>33</td>
<td>36-58 to 36 4</td>
</tr>
<tr>
<td>Water</td>
<td>21</td>
<td>30</td>
<td>27</td>
<td>35</td>
<td>23</td>
<td>21'82 to 20 4</td>
</tr>
</tbody>
</table>

Magnesia alba 100 100 100 100 100 100-00 to 100 9

Several reasons have led chemists to reject the idea of this compound being an ordinary subsalt (vide Berzelius, Traité de Chém. iv. 101); but they are not agreed as to the precise mode in which the constituents are combined, as the following table shews:—

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<tbody>
<tr>
<td></td>
<td>Eq.</td>
<td>Eq.</td>
<td>Eq.</td>
</tr>
<tr>
<td>Magnesia</td>
<td>1 178'31</td>
<td>1 98</td>
<td>1 98</td>
</tr>
</tbody>
</table>

PURITY.—Subcarbonate of magnesia should be perfectly white and tasteless. The water in which it has been boiled should have no alkaline reaction on turmeric paper, nor throw down anything on the addition of chloride of barium or nitrate of silver: by which the absence of alkaline carbonates, sulphates, and chlorides, is proved. Dissolved in dilute sulphuric acid the oxalates and bicarbonates should occasion a precipitate, by which the non-existence of any calcareous salt is shown.

PHYSIOLOGICAL EFFECTS.—The effects of subcarbonate of magnesia are nearly the same as those of pure magnesia. We can readily conceive that the local operation of the first is somewhat milder than that of the latter (as in the case of the alkalies and their carbonates), but the difference is hardly perceptible in practice. As the subcarbonate effervesces with acids it is more apt to create flatulence when swallowed.

USES.—The uses of the subcarbonate are the same as those of calcine magnesia; except where the object is to neutralize acid in the alimentary canal (as in cardialgia and in poisoning by the mineral acids), when the latter preparation is to be preferred on account of its not effervescing with acids, and thereby not causing flatulence.

In the Pharmacopoeia, subcarbonate of magnesia is directed to be employed for the extemporaneous preparation of the so-called Distillate Waters (aqua distillata). A drachm of any distilled oil is to be carefully triturated with a drachm of subcarbonate of magnesia, and afterwards with four pints of distilled water; the water is then to be strained. For ordinary purposes no objection exists to the use of waters thus prepared, but they are incompatible with bichloride of mercury, on account of the small quantity of magnesia which they hold in solution.

ADMINISTRATION.—The dose of subcarbonate of magnesia, as a purgative, is from ten grains to a drachm; as an antacid, from five grains to a scruple.

AQUA MAGNESIAE BICARBONATIS. (Magnesia Water: Aerated Magnesia Water.)—This solution is prepared by passing a stream of carbonic acid through water in which a given quantity of subcarbonate of magnesia is suspended. Or it may be made extemporaneously by adding subcarbonate of magnesia (or a mixture of sulphate of magnesia and carbonate of soda) to the ordinary bottle-soda water (carbonic acid water.) It is an agreeable mode of exhibiting magnesia in nephritic affections.
SULPHATE OF MAGNESIA.

Magnesie Sulphas.—Sulphate of Magnesia.

History.—This salt was originally procured from the Epsom waters by Dr. Grew in 1675. It has had a variety of names, such as Epsom or bitter purging salt, sal Anglicum, sal Seidlitzense, sal catharticum, isolated magnesia, &c.

Natural History.—It is a constituent of sea and many mineral waters; it occurs as an efflorescence on other minerals, forming the hair of mineralogists; and with sulphate of soda and a little chloride of sodium, constitutes Reussite.

Preparation.—The two great sources of the sulphate of magnesia of fish commerce are dolomite and bittern. Dolomite or magnesian stone is a compound of carbonate of lime and carbonate of magnesia. It occurs in enormous quantities in various counties of England (as those of Somerset, York, and Nottingham), and is employed for building. The Minster and Westminster Hall are built of it. Bittern is the residual liquor of sea-water, from which common salt (chloride of sodium) has been separated. It contains chloride of magnesium and sulphate of magnesia.

Sulphate of magnesia may be extracted from bittern by evaporation, a process practised at Lymington, in Hampshire (Dr. Henry, Phil. Trans. 1816, p. 94). If sulphuric acid be added to bittern, a further quantity of bittern may be obtained by the decomposition of chloride of magnesia. Sulphate thus procured is preferred at Apothecaries’ Hall for mixing magnesia, as it yields a whiter product than sulphate made from dolomite.

Various methods of manufacturing sulphate of magnesia from dolomite have been described. The usual method is to treat this mineral by the sulphuric acid: carbonic acid escapes, and a residue, composed of carbonate of magnesia and sulphate of lime, is obtained. These two salts are separated from each other by crystallization.

In 1816, Dr. William Henry, of Manchester (Repert. of Arts, vol. xxx. 1812, 2nd Ser.) took out a patent for the following process:—Calcine the magnesian limestone, so as to expel the carbonic acid; then convert the vitric lime and magnesia into hydrates by moistening them with water. Towards add a sufficient quantity of hydrochloric (or nitric or acetic) (or chlorine), to dissolve the lime, but not the magnesia, which, being washed, is converted into sulphate by sulphuric acid (or, if the cost of this is objectionable, by sulphate of iron, which is not decomposed by magnesia). Or the mixed hydrates of lime and magnesia are to be added to bittern: chloride of calcium is formed in solution, while two portions of magnesia (one from the bittern, the other from the magnesian lime) are left undissolved. Or hydrochlorate of ammonia may be used instead of bittern: by the reaction of this on the hydrated magnesian lime, chloride of calcium and caustic ammonia in solution, while magnesia is left undissolved: the ammonia is separated from the decanted liquor by distillation.

Carbonate of ammonia has also been employed to separate lime from magnesia: carbonate of lime is precipitated, and the magnesia remains solution, from which it may be easily separated by ebullition (Journ. Science, iii. 217; vi. 313; ix. 177). At Monte della Guardia, near
Genoa, sulphate of magnesia is manufactured from schistose mineral containing sulphur, magnesia, copper, and iron. After being roasted, it is moistened to convert them into sulphates, they are lixiviated, and the solution is deprived, first, of copper by refuse iron, and afterwards of iron by lime (Dr. Holland, *Phil. Trans. 1816*, p. 294). In Bohemia, sulphate of magnesia is procured, by evaporation, from the waters of Seidlitz and Saidenschütz. Hernann (Poggendorff’s *Annalen*, xi. 249) extracts it from liquids containing chloride of magnesium, by means of sulphate of soda. At Baltimore, sulphate of magnesia is procured from the siliceous hydrate of magnesia or marmolite, by reducing the mineral to powder, saturating with sulphuric acid, and calcining the dried mass to peroxidize the iron. It is then re-dissolved in water (from which solution the remaining iron is separated by sulphuret of lime), and crystallized. By a second crystallization it is obtained nearly pure (D. B. Smith, in the *Dispensatory of the U. S. of America*).

Properties.—The impure sulphate obtained from bittern is called **singles**, and when purified by re-crystallization, **doubles**. The sulphate usually met with in the shops is in small acicular crystals. By solution and re-crystallization we readily obtain tolerably large four-sided prisms with reversed diedral summits, or four-sided pyramids: the prism form of the crystals is the right rhombic prism. Both large and small crystals are colourless, transparent, and odourless, but have an extreme bitter taste. When heated they undergo the watery fusion, then give up their water of crystallization, become anhydrous, and at a high temperature undergo the igneous prism, and run into a white enamel, but without suffering decomposition. Exposed to the air the crystals very slowly at a slightly effloresce. It dissolves in its own weight of water at 60°, and three-fourths of its weight of boiling water. It is insoluble in alcohol.

Characteristics.—It is known to contain sulphuric acid by the tests for the sulphates already mentioned (p. 265). The nature of its base shown by the tests for magnesia before described (p. 361).

Composition.—The following is the composition of crystallized sulphate of magnesia:

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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Magnesia</td>
<td>1</td>
<td>20</td>
<td>16:26</td>
<td>16:04</td>
<td>16:86</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>32:52</td>
<td>32:53</td>
<td>30:64</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
<td>63</td>
<td>51:22</td>
<td>51:43</td>
<td>52:50</td>
</tr>
<tr>
<td>Cryst.</td>
<td></td>
<td>123</td>
<td>100:00</td>
<td>100:00</td>
<td>100:00</td>
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</tbody>
</table>

Purity.—The sulphate of magnesia met with in the shops is usually sufficiently pure for all medicinal and pharmaceutical purposes, should be colourless, and undergo no change when mixed with ferricyanides or hydrosulphurets. When obtained from bittern it is sometimes contaminated with chloride of magnesium, which, by its affinity for water, keeps the sulphate in a damp state. By digestion in alcohol the chloride is dissolved, and by evaporating the spirituous solution, may be obtained in the solid state. It is said, that occasionally small crystals of sulphate of soda are intermixed with those of sulphate of magnesia— a fraud I have never met with in English commerce, nor is it likely to occur at the present low price of the magnesian salt. Should such an adulteration be suspected, there are several methods of detecting it; the most sophisticated salt would effloresce more rapidly than the pure salt, and would communicate a yellow tinge to the flame of alcohol. Boiled wit
SULPHATE OF MAGNESIA.

Sulphatic lime and water, all the magnesian sulphate would be decomposed, the liquor being filtered, to separate the precipitated magnesia and phate of lime, yields, on evaporation, sulphate of soda. If shaken in cold with carbonate of baryta, a solution of carbonate of soda would obtained, easily recognized by its alkaline properties. 100 grains of the sulphate of magnesia, dissolved in water, and mixed with a boiling solution of carbonate of soda, yields 34 grains of subcarbonate of magnesia when dried. If sulphate of soda were present, the precipitate would weigh less. (Phillips, Transl. of Pharm.)

PHYSIOLOGICAL EFFECTS.—Sulphate of magnesia is a mild and perfectly safe antiphlogistic purgative, which promotes the secretion as well the peristaltic motion of the alimentary canal. It is very similar in operation to sulphate of soda, than which it is less likely to nauseate, otherwise disorder the digestive functions, while it acts somewhat more speedily on the bowels. It does not occasion nausea and griping, as some of the vegetable purgatives, nor has it any tendency to create bile disorder or inflammatory symptoms; but, on the other hand, has refrigerant influence: hence it is commonly termed a cooling purgative. Small doses, largely diluted with aqueous fluids, it slightly promotes action of other emunctories: thus, if the skin be kept cool, and moderate exercise be conjoined, it acts as a diuretic; whereas if the skin warm, it operates as a diaphoretic.

USES.—On account of the mildness and safety of its operation, its dry solubility, and its cheapness, sulphate of magnesia is by far the most commonly employed purgative, both by the public and the profession. The only objection to its use is its bitter and unpleasant taste. To be all the cases in which it is administered, would be to enumerate nearly the whole catalogue of known diseases. It must, therefore, be sufficient to mention, that it is excellently well adapted as a purgative for febrile and inflammatory diseases, obstinate constipation, ileus, lead colic, even necerated hernia, narcotic poisoning, &c. It may be used as an antidote in poisoning by the salts of lead and baryta.

ADMINISTRATION.—As a purgative it is usually administered in doses from half an ounce to an ounce and a half; but if dissolved in a large quantity of water, a smaller dose will suffice. Thus, two drachms in a pint or more of water, taken in the morning fasting, will act mildly, sufficiently, and mildly, in ordinary cases; and in delicate males, a drachm, or even less, in the above quantity of water, will finally produce the desired effect. Some carminative or aromatic (as peppermint water or tincture of ginger) is frequently conjoined to obviate dulency. In febrile and inflammatory diseases, the solution may be diluted with dilute sulphuric acid with great advantage; or the sulphate may be dissolved in the compound infusion of roses. It is frequently used as an adjunct to the compound infusion of senna, whose purgative effect it promotes, but whose griping tendency it is said to check. In dyspeptic cases, accompanied with constipation, it is con- nected with bitter infusions (as of quassia, gentian, calumba, &c.). As a negative enema, an ounce or more of it may be added to the ordinary water.

The bitter purging saline waters (vide p. 174), as those of Scidlitz, Dson, Benlah, Kilburn, and the Cheltenham pure saline, owe their purgative property principally to sulphate of magnesia.
Order 15. Compound of Aluminum.

Potas'sæ Alumino-Sul'phas seu Alu'men.—Aluminum-Sulphate of Potas, or Alum.

History.—Although the term alum (alumen of the Romans—στυφωνι of the Greeks) occurs in the writings of Herodotus (Euterpe, clxxx. Hippocrates (De fistulis, De ulceribus, &c.), Pliny (Hist. Nat. xxxv. Dioscorides (Lib. v. cap. 123), and other ancient writers, yet it is not satisfactorily proved that our alum was the substance referred to. On the contrary, the learned Beckmann (Hist. of Invent. i. 288) has asserted that the alum of the Greeks and Romans was sulphate of iron, and that the invention of our alum was certainly later than the 12th century. But Geber (Search of Perfection, ch. iii., and Invention of Verity, ch. iv.) who is supposed to have lived in the 8th century, was acquainted with three kinds of our alum, and describes the method of preparing burn alum; and it is not, I think, improbable, that even Pliny was acquainted with our alum, but did not distinguish it from sulphate of iron, for he tells us that one kind of alum was white, and was used for dyeing wool of bright colours.—[For further information, consult Parkes’s Chemical Essays, i. 625, and Thomson’s Hist. of Chem. i. 125].

Natural History.—It is found native in the neighbourhood of volcanoes, and constitutes the mineral called native alum. Native alum occurs in bituminous shale and slate clay, at Hurlett, near Paisley, and near Whitby, in Yorkshire.

Preparation.—The method of preparing alum varies somewhat in different places. The mineral from which (in this country) it is procured is called aluminous slate, aluminous shale, or aluminous schist (schista aluminaris). This substance varies somewhat in its composition in different localities, but always contains sulphuret of iron, alumina, carbon and sometimes a salt of potash. The most extensive alum manufacturer in Great Britain is at Hurlett, near Paisley. Here the aluminous schist lies between the stratum of coal and limestone (Williams, Nat. Hist. & the Mineral Kingdom, 2nd. ed. ii. 315). By the action of the air it undergoes decomposition, and falls down on the floor of the mine. The sulphur attracts oxygen, and is converted into sulphuric acid, which combines partly with the iron (oxidized by the air), and partly with the alumina. The solution obtained by lixiviating the decomposed schist is evaporated, and the sulphate of iron allowed to crystallize: to the mother liquor, which contains sulphate of alumina, sulphate of potash is added, by which crystals of alum are procured, which are purified by a second crystallization.

At Whitby, in Yorkshire, the method of making alum is somewhat different. The schist is piled in heaps, and burnt by means of a slow, smothered fire. The calcined ore is lixiviated, and a salt of potash added to the solution after it has deposited sulphates of lime and iron and earthy matters (Winter, in Nicholson’s Journal, vol. xxv.)

Properties.—Alum crystallizes usually in regular octahedrons, frequently with truncated edges and angles, and sometimes in cubes. The ordinary alum of the shops consists of large crystalline masses, which d
present any regular geometrical form; but, by immersion in water for a few days, octahedral and rectangular forms are developed in its faces. (Daniel, Quart. Journ. i. 24.) Alum has an astringent and elastic acid taste: its reaction on vegetable colours is that of an acid. \( \text{sp. gr. is } 1.7 \). By exposure to the air it slowly and slightly effloresces. Its translucent or diathermanous power is very slight.

When heated, alum undergoes the watery fusion, swells up, gives out water of crystallization, and becomes a white spongy mass, called \textit{id} or \textit{burnt alum} (\textit{Alumen Exsiccatum}, Ph. L., \textit{alumen ustum}), which is more astringent taste, and does not so quickly dissolve in water as crystallized salt. If too much heat be applied a portion of the acid expelled, and escapes, partly as sulphuric acid, partly in the form of gen and sulphurous acid, and the residue consists of alumina and sulphate of potash: the acid liquor obtained by heating alum was formerly used as \textit{spirit of alum}. In the preparation of burnt alum care should be taken not to apply too great a heat in order that the acid may not be driven off. On this account a shallow earthen vessel is preferable to a cible.

When alum is calcined with charcoal or some carbonaceous substance, sugar, we obtain a spontaneously inflammable substance called \textit{Hom-Fis Pyrophorus}, composed of sulphur, potash, alumina, and charcoal. Alum dissolves in 18 times its weight of cold and less than its own weight of boiling water.

The alum procured at Tolfa and other parts of Italy, and called \textit{tolyen alum} (\textit{alumen Romanum}) is covered with a pale, rose-coloured prescence, composed of oxide of iron and an aluminous sulphate of potash. Under the name of Roche or \textit{Rock alum} (\textit{alumen rufeum}, seu \textit{alumen de Rochi}, so called from Roccha, in Syria, whence a red-dusted alum was formerly brought) we find in English commerce crystalline fragments of alum, not larger than almonds, coloured externally in bole or rose-pink.

\textbf{Characteristics.}—That alum is a sulphate is shewn by the tests for soluble sulphates already mentioned (p. 265). It reddens litmus, and is a sulphate of lead when mixed with pure carbonate of lead: in these properties it agrees with the supersulphates. The nature of its basic constituents is shewn by the following tests:—The ferrocyanides, the carbonates, and hydrosulphuric acid, occasion no precipitate in a solution of alum. Hydrosulphuret of ammonia, the caustic alkalies and their bonates, and phosphate of soda, throw down white precipitates: that produced by the alkalies is soluble in an excess of alkali, but is insoluble solutions of the carbonated alkalies: these characters shew the presence of alumina. Potash is recognised by perchloric acid and chloride of Platinum (vide p. 274.) Lastly, the crystalline form of the salt assists recognising it.

\textbf{Composition.}—The composition of alum is as follows:—

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>\textit{Alumina}</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td>\textit{Hydrosulphoric Acid}</td>
<td>4</td>
<td>160</td>
</tr>
<tr>
<td>\textit{Water}</td>
<td>25</td>
<td>223</td>
</tr>
</tbody>
</table>

\{ Sulphate of Alumina 3 \( 174 \) | 33·728 \\
Sulphate of Potash 1 \( 88 \) | 18·069 \\
Water 25 | 223 | 46·201 \\
\}

\textit{Cryst. Al unin.} \\
Sulphate of Potash 1 \( 487 \) | 99·998 \\

In the above table I have assumed, with Thomson, Brande, and Phil-
lips, alumina to be a protoxide of aluminum, and that its equivalent is 18.
Berzelius and Turner regard it as a sesquioxide, and adopt 51.4 as its
equivalent. According to the views of the latter chemists the equivalent
for alum \( \left( \text{K}_2\text{S} + \frac{1}{2} \text{Al}_2\text{S}_3 + 25 \text{H} \right) \) is 474.95.

**Purity.**—Alum should be colourless, completely soluble in water (by
which the absence of uncombined earthy matter is shewn), with a solution
of caustic potash or ammonia should form a colourless precipitate of
hydrate of alumina soluble in excess of alkali, and should not suffer any
change of colour by the addition of tincture of nutgalls or hydrosulphuric
acid. The ferro-sulphate of potash, sometimes mixed with alum, cannot
be distinguished from the latter, by its form, colour, or taste; but is
readily detected by potash, which throws down oxide of iron, and by tinc-
ture of nutgalls, which communicates a bluish black colour to it.

**Physiological Effects.** (a.) On vegetables.—Alum is probably inju-
rious to plants. (Decandolle, *Physiol. Végét.* 1341).

(b.) On animals.—Dogs support large doses of alum with impunity
Orfila (*Ann. d'Hyg. Publq. et de Méd. Lég.* i. 235) gave seven drachms of
crystallized alum in powder to dogs: the animals retained it for from ten
to thirty minutes, then vomited, and in an hour or two were apparently
well. Two ounces of burnt alum in four ounces of cold water occas-
ioned vomiting only. When the oesophagus was tied to prevent
vomiting, death took place in five hours with symptoms of great ex-
haustion and diminished sensibility. On a post-mortem examination
the mucous membrane of the stomach was found inflamed in the whole of
its extent. One ounce of finely-powdered burnt alum applied to the
subcutaneous cellular tissue of the thigh, caused excessive suppuration
and death in fifteen hours. Devergie (*Méd. Légale*, ii. 653) found burnt
alum somewhat more active: he says 6½ drachms killed a dog when the
oesophagus was tied, and 2 ounces when it was not tied. Moreover, he
found burnt alum suspended in cold water, more active than when dis-
solved in warm water. Veterinarians employ it in doses of from 1 to
4 drachms for large animals. Bourgelat has seen a phthisical condition
induced in horses by the use of alum in too great quantities. (Moiron,
*Pharm. Vétér.* 225.)

c.) On man.—The immediate topical effect of a solution of alum is
that of an astringent, namely, corrugation of fibres and contraction of
small vessels, by virtue of which it checks or temporarily stops exhal-
ation and secretion, and produces paleness of parts by diminishing the
diameters of the small blood-vessels. It is by these local effects that
alum, when taken internally, causes dryness of the mouth and throat,
and thereby increases thirst, checks the secretions of the alimentary canal
and thereby diminishes the frequency and increases the consistency of
the stools, as observed by Wibmer (*die Wirkung*, &c. i. 114) in his expe-
riments made on himself, with alum in doses of 3 grains dissolved in
3 drachms of water, and taken several times during the day.

But when alum is applied to a part in larger quantities, and for a
longer period, the stricture is soon followed by irritation, the paleness
by preternatural redness. And thus taken internally in large doses, alum
excites nausea, vomiting, griping, purging, and even an inflammatory
condition of the intestinal canal,—effects which may be perhaps induced
by small quantities in persons endowed with unusual or morbid sensibi
ty of the stomach and bowels, as in the case of the lady in whom dan-
gerous gastro-enteritis was apparently induced by a single dose of a solu-
tion containing between 10 and 20 grains of burnt alum (Ann. d'Hyg. ublique et de Méd. Lég. i.) Ordinarily, however, tolerably large doses
alum may be given without any unpleasant effects. Thus Professor
umeril has given a drachm, properly diluted, in chronic diarrhœas,
within twenty-four hours: Professor Marc, two drachms, in passive
orrhages, within the same period of time: and MM. Kapeler and
endrin have administered 3 drachms, at one dose, in colica pietomum.
Oeverige, Méd. Lég. ii. 656.)

After its absorption, alum appears to act as an astringent or astringent-
monic on the system generally, and to produce more or less general astring
on of the tissues and fibres, and a diminution of secretion. Such an
act appears to be its effects in some passive hemorrhages and mucous
charges. Barbier (Traité Elément. de Mat. Méd. 2d ed. i. 440) says
um "irritates the lungs and often provokes cough," but I am not aware
any other practitioner having confirmed this statement. Kraus (Heil-
tellelehre, 255) observes, that the urine becomes remarkably acid from
the use of alum.

USES.—Alum is employed both as an external or topical, and as an
ternal remedy.

(a.) As a topical remedy.—Burnt or calcined alum is employed as a
ry mild escharotic to destroy exuberant spongy granulations, commonly
own by the name of proud flesh.

(Solutions of alum are sometimes employed to produce contraction or
rregation of the tissues, and thereby to prevent displacements of parts,
especially when accompanied with excessive secretion. Thus it is used
a gargle in relaxation of the uvula with evident advantage. In the
early stage of prolapsus of the rectum, a solution of alum, applied as a
ash, is sometimes of service, especially when the disease occurs in
ants. Washes or injections containing alum are of occasional benefit
prolapsus of the uterus.

In hemorrhages, whether proceeding from an exhalation or exudation
on the extremities or pores of the minute vessels, or from the rupture of
blood-vessel, a solution, or, in some cases, the powder of alum, may be
ed with advantage as a styptic, to constrict the capillary vessels, and
ose their bleeding orifices. Thus in epistaxis, when it is considered
visable to arrest the hemorrhage, assistance may be gained by the
rection of a solution of alum into the nostrils, or by the introduction of
moistened with the solution. Where this fails to give relief, finely
dered alum may be employed in the manner of snuff. In hemor-
age from the mouth or throat, gargles containing alum are useful. In
ematemesis, as well as in intestinal hemorrhage, alum whey may be
istered, though of course no reliance can be placed on it, as the
orrhage usually depends on circumstances which astringents merely
ot be expected to obviate. In uterine hemorrhage a sponge soaked
a solution of alum may be introduced into the vagina with good effect.
ch the hemorrhoidal flux when immoderate, washes or enemata
aining alum may be employed. To stop the bleeding after leech-
es in children, a saturated solution, or the powder of alum, may be
plied to the punctures.

In certain inflammations, alum has been used as a repellent; that is, it
has been applied to the inflamed part in order to produce contraction of the distended vessels, and thereby to diminish the quantity of blood in the seat of the disease in a manner almost mechanical. Thus, in the first stage of ophthalmia, it is sometimes considered expedient to cut short the disease by the application of a strong astringent solution (as a saturated solution of alum or of acetate of lead). "It is not to be denied," observes Dr. Jacob (Cyclopaedia of Prac. Med. art. Ophthalmia), "that such applications may have the effect of arresting the progress of the disease at once; but if they have not that effect, they are liable to produce an increase of irritation." But, as the details necessary for making the student acquainted with all the circumstances respecting the use of stimulating or astringent applications in the first stage of ophthalmia are too lengthened and numerous to admit of their proper discussion in this work, I must refer for further particulars to the essay of Dr. Jacob before quoted, as well as to the treatises of writers on ophthalmic surgery. I may, however, add, that whatever difference of opinion exists as to the propriety of these applications in the first stage of ophthalmia, all are agreed as to their value after the violence of vascular action has been subdued.

In angina membranacea, called by Bretonneau (Rech. sur l'Inflamm. spéc. du Tissu Mucueux, 1826) diptheritis, great importance has been attached to the employment of local applications. Of these hydrochloric acid, calomel, and alum, have, in succession, been highly praised by this writer. In order to promote the expulsion of the false membrane, he recommends the insufflation of finely-powdered alum. This is effected by placing a drachm of it in a tube, and blowing it into the throat. (See also Trousseau and Pidoux, Traité de Thérap. ii. 291). Velpeau has subsequently confirmed the statements of Bretonneau, and extended the use of alum to other inflammatory affections of the throat, as those arising in scarlatina, small-pox, &c. In these cases powdered alum may be applied to the affected parts by means of the index finger. Gargles containing this salt will be found useful in most kinds of sore throat, ulcerations of the mouth and gums, aphtha, &c. In inflammation of the vulva, accompanied with membraniform exudation, alum washes are serviceable both in children and adults (Trousseau and Pidoux, op. cit.)

Alum has been employed as an astringent, to diminish or stop excessive secretion from the mucous surfaces. Thus, a weak solution of this salt is used to repress the discharge in the latter stages of conjunctival inflammation; to check profuse ptyalism, whether from the use of mercury or other causes; and to remove gleet or leucorrhœa. In old-standing diarrhœas it has been administered, in combination with the vegetable astringents (kino, for example), with occasional advantage. It is also applied to check profuse secretion from ulcers.

(b.) As an internal remedy.—Alum has been employed, in conjunction with nutmeg, as a remedy for intermittents. Given just before the expected paroxysm, it has in some cases prevented it (Cullen, Materia Medica).

In the treatment of lead colic, alum has been found more successful than any other agent or class of remedies. It was first used in this disease by a Dutch physician, named Grashuis (De Colica Pictorum, Amst. 1752, et Append. 1755), and was afterwards administered in fifteen cases by Dr. Percival (Essays, Med. & Exper. ii. 194) with great success.
as efficacy has been fully established by Kapeler, physician to the hôpital St.-Antoine, in Paris, and Gendrin (quoted by Trouseau and idoux, op. cit.) and by Dr. Copland (Dict. of Med. i. 374), as well as by several other distinguished authorities. It allays vomiting, abates flatulence, mitigates pain, and opens the bowels more certainly than any other medicine, and frequently when other powerful remedies have failed. It should be given in full doses (as from a scruple to two drachms), dissolved in some demulcent liquid (as gum-water) every three or four hours. Alum and (according to Dr. Copland) camphor may be advantageously conjoined. Kapeler also employs oleaginous enemata. The modus operandi of alum in lead colic is not very clear. The benedict has been ascribed by some to the chemical action of the sulphuric acid on the lead supposed to be contained in the intestines; and in support of this view must be mentioned the fact, that other sulphates (as those of magnesia, soda, zinc, and copper) as well as the sulphuric acid, have been successfully employed in lead colic. But, on the other hand, the presence of lead in the primae vie or evacuations, and, consequently, the formation of sulphate of lead in saturmine colic, have not been demonstrated; though the experiments of Dr. C. G. Mitscherlich (Müller's Archive, No. V. 353, 1836, quoted in Brit. Ann. of Med. vol. ii. 204, 1837) have shown, that when the acetate of lead is swallowed, the greater part of it forms an insoluble combination with the gastrointestinal mucus, and in this state may remain some time in the alimentary canal. Moreover, alum has been found successful by Kopp (Denkwürdigkeit, i. 342, quoted by G. A. Richter, ausführ. Arzneim. appl. Bd. 515) in other varieties of colic not caused by lead, and accompanied by constipation. Dr. Copland is disposed to ascribe the benefit of alum, and other sulphates in lead colic, to their " exciting the action of the partially paralysed muscular coat of the bowels, and thereby enabling them to expel retained matters of a morbid or noxious description,"—an explanation which is inconsistent with the observation of Kopp just quoted.

Alum is administered internally in several other diseases, of which a brief notice only can be given. In passive or asthenic hemorrhages from distant organs; as hæmoptysis, menorrhagia and other uterine hemorrhages, hæmaturia, &c. In colliquative sweating, diabetes, gleet, and leucorrhea. Kreysig (Die Krankh. d. Herzens, Bd. ii. Abt. 2, S. 714, Richter, op. cit.) has advised its use in dilatation of the heart and aortic emulsion. More recently Dzondi (Aeskelap. Bd. I, St. 1, 1821, in Richter) has also recommended it in these diseases; and Sundelin (Heilmittelllehre, 1. 278) has mentioned a case of supposed dilatation of the heart, in which relief was gained by the use of alum. In chronic diarrhœa, alum is occasionally serviceable.

Administration.—The dose of alum is from ten grains to one or two drupes. It may be taken in the form of powder, or made into pills with some tonic extract, or in solution. To prevent nausea, an aromatic nutmeg should be conjoined. A pleasant mode of exhibition is in the form of alum whey (serum aluminosum, seu serum lactis aluminatum), prepared by boiling two drachms of powdered alum with a pint of milk, then straining: the dose is a wine-glassful. The saccharum aluminatum of the Prussian Pharmacopeia is composed of equal parts of white sugar and alum: it may be given to children as well as adults. In prescribing
alum, it is to be recollected that the vegetable astringents decompose it; by which the astringent property of the mixture is probably diminished.

For topical uses, alum is used in the form of powder, solution, and poultice. The powder of burnt alum is sprinkled over ulcers, to destroy spongy granulations. Powder of crystallized alum is applied to the mouth and throat as before mentioned. Solutions of alum are made, for topical purposes, of various strengths, according to the object in view.

The *Cataplasm Aluminis*, Ph. Dub. (*Alum cœrd of Riverius, Albumen Aluminosum*) is prepared by shaking the whites of two eggs with a draught of alum. "In cases of chronic and purulent ophthalmia, it is applied to the eye between two folds of old linen. It has been praised as a good application to chilblains which are not broken" (Barker and Montgomery's *Observations on the Dub. Pharm.*).

The *Liquor Aluminis Compositus*, Ph. L. (*Aqua aluminosa Bateana, or Bates's alum water*) consists of alum, sulphate of zinc—each an ounce; boiling water, three pints: dissolve and strain. It is used as a detergent and astringent wash in old ulcers; when diluted, as a collyrium in mild conjunctival inflammation, as an injection in gleet and leucorrhoea, and as an application to chilblains and slight excoriations.

**Antidote.**—In a case of poisoning by alum, let the contents of the stomach be immediately evacuated. Promote vomiting by the use of tepid diluents. The inflammatory symptoms are to be combated by the usual antiphlogistic means. Magnesia has been employed, but is said by Devergie to be altogether useless.

**Order 16. Compounds of Arsenicum.**

*Acidum Arseniosum.*—*Arsenious Acid.*

**History.**—Arsenious acid, commonly termed white arsenic (*arsenicum album*) or oxide of arsenic, is first distinctly mentioned by Geber (*Invent. of Verity, ch. vii.*), who seems to have been also acquainted with metallic arsenic (*Sum of Perfection, book i. part iv. ch. ii.*) Hippocrates (*De Ulceribus*) employed ἅφερσιν (orpiment or sesquisulphuret of arsenicum) and σαμαράκι (realgar or sulphuret of arsenicum) as topical remedies. Dioscorides (*lib. v., cap. xxii.*) is the first author who uses the word ἅρσενίκιν (orpiment).

**Natural History.**—Arsenious acid occurs only in the mineral kingdom. It is rather a rare mineral, and is found at Andreasberg, in the Hartz; at Joachimsthal, in Bohemia; and at some few other places.

**Preparation.**—It is prepared in Silesia, Bohemia, Saxony, and Cornwall.

At Altenberg it is obtained from arsenical iron (*Mispickel*), a compound of arsenicum, iron, and sulphur. After being reduced to powder the ore is roasted in a muffle furnace (fig. 56), by which the arsenicum is converted into arsenic acid. This is conveyed in the state of vapour, called *flowers of arsenic* or *smeltinghouse-smoke* (*Hüttenrauch*), into the condensing chamber (fig. 57), where it is deposited in a pulverent form, and in this state is called *rough arsenious acid*, or *poison-flour* (*Giftmehl*).

The rough arsenious acid is refined by sublimation. This is effected in cast-iron pots, as shown in fig. 58, p. 376, to which cylindrical iron
heads (d) are attached, which at the tops are contracted into cones (e), each terminating in a pipe made of sheet iron, and communicating with the condensing chamber (fig. 57). Heat is applied for twelve hours, by which the acid is sublimed and condensed on the sides of the iron head in the form of a glassy mass, called glacial white arsenic (weissen Arsenikglas), which is sometimes purified by a second, or even third sublimation. If it contain any sulphuret of arsenicum, a little potash is mixed with it, to prevent the sublimation of the sulphur.

At Reichenstein, arsenious acid is procured from the mineral called arsenical pyrites (a compound of arsenicum and iron, with a small portion of sulphur).

Arsenious acid is procured in some parts of Saxony as a secondary product in the roasting of cobalt ores (the arsenicts of cobalt). It is deposited in long horizontal flues (poison-flues, or Giftflügen), and is purified by sublimation. (For other particulars consult the paper of J. H. Vivian, Trans. Royal Geol. Society of Cornwall, i. 60).

Arsenious acid is manufactured in Cornwall. In the impure state it is deposited in the long horizontal flues of the tin burning houses (Mr. J. Taylor, Ann. Phil. N.S. iii. 82); from which it is taken for the use of refiners, its value being about shillings per ton (Quart. Min. Rev. vol. ii. p. 88; and Mr. Davies is indebted for samples of this impure obtained from Wheal Vor tin-mine), tells me that it is conveyed in wagons to the arsenic-works, of which there are two in the neighbourhood of Truro; one in the parish of Perran Arworthall, the other Bissow, in the parish of Kea; the former about half a mile, the latter more than a mile, from the Devoron and Carnon stream-works. Here it is purified by sublimation. The fumes from these works are most injurious to the neighbouring vegetables and animals. In the human subject, exceptions, principally about the lips and nose, are produced by them. In 1826, eighty-three tons of manufactured arsenic were shipped at Penryn (Trans. Royal Geol. Soc. of Cornwall, iii. 360).
Properties.—When recently prepared, arsenious acid is in the form of large, glassy, transparent cakes, sometimes colourless, at others having a yellowish tinge. Frequently the cakes consist of concentric laminae, formed by successive sublimations. Most curiously, these masses soon become opaque and white externally, like enamel, the opacity gradually extending towards the centre; and, in some cases the acid becomes friable and pulverulent. On what does this alteration depend? Krüger (Kastn. Arch. ii. 478, quoted in Gmelin’s Handb. d. Chem.), ascribes the change to the absorption of water from the atmosphere, for he says it only takes place in moist air, and is attended with an increase of weight, but only to the extent of \( \frac{4}{17} \) of the whole mass. Mr Phillips (Transl. of the Pharm. 3d. ed. 1838) has taken the same view of the subject. But, as Berzelius has observed, the augmentation of weight is too trivial to admit of this explanation. Moreover, I find the opacity takes place in an air-tight vessel. Does not the opacity (as in opaque gum arabic) depend on innumerable cracks, imperceptible from their minuteness? Professor Guibourt, Mr Phillips, and Mr. Taylor, have each found the density of the opaque variety to be less than that of the transparent. Transparent arsenious acid has a sp. gr. of 3·7391, according to Guibourt (3·715, Phillips 3·208 to 3·333, Mitchell and Durand; 3·798, Taylor.) It dissolves, according to the same authority, in 103 parts of water at 59°, or in 93 parts of boiling water, and the solution feebly reddens litmus. Opaque arsenious acid, on the other hand, according to Guibourt, has a sp. gr. of 3·695 (3·529, Taylor; 3·620, Phillips), is soluble in 80 parts of water at 59°, or in 7·72 parts of boiling water, and the solution restores the blue colour of reddened litmus. But I find both kinds redder litmus, and Dr. Christison has observed the same. Mr. Taylor (Guy’s Hospital Reports, vol. ii. p. 83), did not find any difference in the solubility of the two varieties. He found that water boiled for an hour on this substance dissolved \( \frac{9}{4} \) of its weight; that this water on perfect cooling did not retain more than \( \frac{4}{5} \) of its weight; and that water at ordinary temperatures will dissolve from about \( \frac{2}{5} \) to \( \frac{1}{5} \) of its weight. It appears, then, that water perfectly cooled from a boiling saturated solution will retain from ten to twenty or more times the quantity of acid in solution than it will take up at common temperatures without heat,—a fact which is as curious as it is inexplicable (op. cit. p. 96.) Arsenious acid is soluble in alcohol and oils. It is of importance to know that the presence of organic matters very much impairs the solvent power of water for this acid—a circumstance which readily explains why arsenious acid has not in some cases, been found in the liquid contents of the stomach of persons poisoned by it. Arsenious acid has little or no taste, as Plenck (Toxicologia, ed. 2nd. 26), Addison, and Christison, have remarked: and neither in the solid nor vaporous form has it odour. The acid may be readily obtained in a crystalline condition by sublimation or by cooling a boiling saturated solution: the crystals are transparent, usually regular octahedra, sometimes tetrahedra or acicular. At a temperature of 385° F it volatilizes: when heated under pressure it liquefies, and is converted into a transparent glass.
Characteristics.—These may be conveniently and usefully discussed under three heads:—(a) The characteristics of solid arsenuous acid; (b) the characteristics of a pure solution of arsenuous acid; (c) the characteristics of arsenuous acid in organic mixtures.

(a) Of Solid Arsenious Acid.—The characteristics of solid arsenuous acid are (besides its physical properties before mentioned) principally three—its volatility, the garlic odour evolved by throwing it on ignited charcoal, and the qualities of the metallic crust obtained by reducing the acid.

1. Its volatility.—Heated on the point of a penknife in the flame of a spirit lamp arsenuous acid produces a white smoke, and speedily disappears. If the acid be heated in a test tube, a crystalline sublimate is obtained: the crystals when examined by a magnifying glass are found to be regular octahedra. The impediments to the operation of this test are alkaline or earthy bases which retain a portion of the arsenuous acid, and prevent its rising in vapour: boracic acid may be used to counteract their influence. The fallacy of this test is, that other white solids (as hydrochlorate of ammonia, oxalic acid, &c.) are volatile, and produce a white smoke when heated.

2. Garlic odour.—If arsenuous acid or an arsenite be put on a red-hot cinder (placed for convenience in a saucer), it evolves a scarcely visible vapour (of metallic arsenicum) having a garlic odour, and which, at the distance of an inch or two from the cinder, is converted into a dense, white, odourless smoke (arsenuous acid.) The deoxidation of the acid is essential to the production of the garlic odour: hence no odour is perceived when arsenuous acid is placed on a heated metallic or glass plate. The impediment to the action of this test is the presence of organic matter (as flour): this, by burning, develops a strong odour, which masks the smell of the vapour of arsenicum. The fallacy attending it is, that some other bodies (as phosphorus, with certain of its compounds and some organic matters) evolve when heated a garlic odour. Vanquelin, Barruel, and Orfila, have shewn that a compound of albumen and fat, which exhale this odour when heated, did not contain a particle of arsenuous acid. “It is true,” say these experimenters, “that arsenicum does evolve garlic odour when volatilized; but even when this is well characterized, it is insufficient to establish the existence of the oxide of arsenic, since it belongs to some other substances; and it is not impossible that there may be developed in the stomach, during digestion, substances which exhale an analogous odour, when heated.”

3. Formation of a metallic crust. Reduction test.—If arsenuous acid be intimately mixed with freshly-ignited but cold charcoal, and heated in a glass tube, the acid is deoxidized, and yields arsenic, which is sublimed into a cooler portion of the tube, where it condenses, and forms a metallic crust. A common cylindrical test tube answers very well, but the reduction tube of Berzelius (fig. 59) is to be preferred. The characters of the arsenical crust are—the brilliancy of its outer surface, which is frequently equal to polished steel or looking-glass; the crystalline appearance and greyish white colour of its inner surface; its volatility; its conversion, by sublimation, up and down the
tube, into octahedral crystals of arsenious acid, which may be dissolved in distilled water, and tested by the liquid re-agents presently to be mentioned; and its yielding arsenic acid by dissolving it in nitric hydrochloric acid, and carefully evaporating the solution to dryness. The arsenic acid is known by the red precipitate (arseniate of silver) produced on the addition of nitrate of silver: but if the evaporation has not been carried on sufficiently far, some hydrochloric acid or chlorine will be left, which will form a white precipitate (chloride of silver) with nitrate of silver. The arseniate of silver may be reduced, if necessary, by mixing it with charcoal and boracic acid, and heating it in a glass tube.

In some cases the metallic crust is imperfectly formed, or is masked by some decomposed organic matter. Whenever any doubt respecting its nature is entertained, proceed as follows:—Cut off with a file the portion of the tube which contains the suspected crust, roughly powder it, introduce it into another glass tube, and apply heat.

The fallacies to which this test is liable are principally two—a charcoal crust may, by an inexperienced experimenter, be mistaken for the arsenical crust; and I have seen students confound a stratum of globular arsenic acid (obtained by reducing calomel) with the arsenical crust. Careful examination, especially by a magnifying glass, will, however, easily enable the experimenter to distinguish them: the inner surface of the charcoal crust is brown, powdery, and dull, whereas that of the arsenical crust has a crystalline texture, grey colour, and shiny appearance. The sublimate obtained by reducing calomel or mercurial compounds has all the brilliancy of arsenic, but by a glass is found to consist of minute globules which may be made to coalesce by the point of a knife. Lastly, the arsenical may be distinguished from all other crusts by oxidating it, as before directed, and converting it into arsenous or arsenic acid which can be readily recognised by the tests already mentioned:—a proceeding which ought never to be omitted.

As a deoxidizing agent I have directed freshly ignited charcoal to be employed to convert arsenious acid into arsenic. If carbonate of soda or of potash be mixed with the charcoal, a part only of the arsenic is disengaged, an arsenuret of sodium or of potassium being formed: hence when the quantity of acid to be reduced is small, charcoal only should be employed. "Where the quantity of material, however, is considerable, it is preferable to employ the black flux, or still better, as not being deliquescent, a mixture of charcoal and carbonate of soda, deprived of water of crystallization by heat." (Christison's Treatise on Poisons, 3d ed. p. 237.) If the substance to be reduced be an arsenite (as of silver, copper, or lime), or an arseniate (as of silver), a mixture of charcoal and boracic acid should be used. For the reduction of the arsenical sulphures (the precipitate obtained by passing hydrosulphuric acid gas through solution of arsenious acid) a mixture of 2 parts of ignited carbonate of soda and 1 of charcoal should be employed. The alkali is here essential in order to combine with the sulphur. Black flux (prepared by grating 1 part of nitre and 2½ of bitartrate of potash) is objectionable on account of its deliquescent property. Various other deoxidizing agents have been recommended, as formate of soda by Goebel (Griffin's Chem. Recreat. 8th ed. 140), oxalate of lime by Du Menil (Handb. d. Reag. u. Zerlegungslehre, ii. 268), and oxalate of soda by Dr. McGregor (London Med. Gaz. xxii. 613.) I find that binoxalate of potash answers ver.
None of these, however, present any advantage over charcoal save of not soiling the tube (an occurrence easily avoided by using a glass tube, as recommended by Dr. Christison, or which may be obviated by using the tube, after the introduction of the mixture, with a wisp of charcoal), while their comparative scarcity and greater cost are objections to their employment. (For further details concerning the reduction process, consult Dr. Christison's Treatise, so frequently referred to.)

1) Characteristics of a pure aqueous solution of Arsenious Acid.—A clear watery solution of white arsenic may be recognized by means of liquid reagents which give rise to peculiar precipitates, as well as the nascent hydrogen, which causes the formation of a gas (arseniuretted hydrogen) possessed of remarkable and peculiar properties. The liquid reactions which deserve notice are four only—namely, lime water, ammoniacosulphate of copper, ammoniac-nitrate of silver, and hydrosulphuric acid. Their relative delicacy, as stated by Devergie, (Med. Lég. ii. 718), the delicacy of the nascent hydrogen test, as ascertained by Mohr (Ann. de Pharm. xxiii. 566), are as follows:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilution of arsenious solution.</td>
<td></td>
</tr>
<tr>
<td>Lime water ceases to act at</td>
<td>2:000</td>
</tr>
<tr>
<td>Ammoniacosulphate of copper, ditto at</td>
<td>3:000</td>
</tr>
<tr>
<td>Hydrosulphuric acid, ditto at</td>
<td>200:000</td>
</tr>
<tr>
<td>Ammoniac-nitrate of silver, ditto at</td>
<td>400:000</td>
</tr>
<tr>
<td>Marsh's nascent hydrogen test, ditto at</td>
<td>500:000</td>
</tr>
</tbody>
</table>

Lime Water.—Lime water occasions a white precipitate (arsenite of lime), with a solution of arsenious acid. The precipitate is soluble in nitric acids. The impediments to the operation of this test are, a large amount of water and free acids, which hold it in solution, and gelatinous oleaginous liquids, which keep it suspended. The fallacies of this test are, carbonates, oxalates, tartrates, &c. which also throw down white precipitates with lime water. On the whole, it is a test of very little value.

Ammoniacosulphate of Copper.—If a dilute solution of ammoniacosulphate of copper be added to a solution of arsenious acid, a pale green precipitate (arsenite of copper, or Scheele's green) is obtained, and sulphate of ammonia remains in solution. This test is prepared as follows:—Add (cautiously) liquor ammonia to a solution of the sulphate of copper, so as to re-dissolve the oxide of copper, which it at first throws down. It must be taken not to employ too much alkali, otherwise the test will not act. Moreover, the solution must not be concentrated, or no precipitate will be obtained. The impediments to the action of this test are straingents, as tea, infusion of galls, &c. which prevent its acting characteristically. The fallacies are to be guarded against, are, yellow-brown and other organic fluids, which give a green colour, and slight precipitate, even though no arsenic be present.

Ammoniac-nitrate of silver: Hume's test.—If a solution of ammoniac-nitrate of silver be added to a solution of arsenious acid, a yellow precipitate (arsenite of silver) takes place, and nitrate of ammonia remains in solution. The precipitate is soluble in liquid nitric acid, ammonia water, a solution of nitrate of ammonia. The mode of preparing this test is follows:—Add a few drops of liquor ammonia to a solution of nitrate of silver, so that the oxide of silver which the alkali at first throws down be nearly, but not entirely, redissolved. Great care is requisite to avoid neither too much nor too little; for if too much be employed, the solution will not occasion any precipitate with arsenious acid; and if too...
little, it will produce a precipitate with phosphate of soda similar
colour to that produced with arsenious acid. The only certain way
knowing when the proper quantity has been employed is to test
Arsenious acid, but not phosphate of soda, ought to occasion a precipi-
tate with it. The impediments to the operation of this test, are, free acids
hydrochloric nitric, acetic, citric, or tartaric), chlorides, and organic me-
ters. The acids may be readily neutralized by an alkali. If common
salt, or other metallic chloride be present, ammoniaco-nitrate of sil-
thus draws down a white precipitate (chloride of silver), even though a co-
siderable quantity of arsenic be present. To obviate this, add a few
drops of nitric acid, then an excess of a solution of nitrate of sil-
Filter to get rid of the precipitated chloride of silver, and apply
ammoniaco-nitrate of silver. The presence of much organic matter i
pedes the action of this test. Ammoniaco-nitrate of silver, when pro-
perly prepared, does not occasion a yellow precipitate with any substi-
tes arsenuous acid; and hence is not subject to any fallacy of that kind.
If, however, it be not properly prepared, it may occasion a yellow pre-
itate (subphosphate of silver) with phosphate of soda. There is
optical fallacy, against which the student should be put on his guard,
if ammoniaco-nitrate of silver be added to certain yellow liquids con-
taining common salt, a white precipitate (chloride of silver) is produced
which, seen through a yellow medium, might, by a careless observer,
mistaken for a yellow precipitate.

4. Hydrosulphuric Acid (Sulphuretted Hydrogen).—If this gas be pass-
through a solution of arsenuous acid, a yellow precipitate of sesquisil-
phuret of arsenicum (orpiment) is produced, while the oxygen of the
arsenuous acid, and the hydrogen of the hydrosulphuric acid, unite
form water. In order, however, for this effect to be produced, it is nec-
sary that the liquid be slightly acidified by some acid (as the hydro-
chloric). If the liquid be already acid, we must neutralize it by ca-
tiously adding an alkali, and then acidify by hydrochloric acid.

In applying this test we may place the suspected liquid in a test-tub
or conical wine or ale-glass (fig. 60); the gas being developed in a co-
mon Florence flask (or two-necked bottle, as recom-
mended by Dr. Christison): the mouth of the flask
closed by a cork, perforated by a tube curved twice
right angles. The ingredients for developing the gas
are a metallic sulphuret (as of iron or of antimony) in
sulphuric or hydrochloric acid. I prefer the sulph-
ur of iron with sulphuric acid diluted with water. The
are to be introduced into the flask previous to the
adaptation of the cork. After the gas has passed
through the arsenical liquid for a few minutes, portions
of the yellow sesquisulphuret of arsenicum (orpiment)
begin to fall down. The separation of the precipitate
is promoted by ebullition, and the exposure of the
solution for a few hours to the air. The essential char-
acters of the precipitate are, its yellow colour, a
rapid solution in liquor ammonia, forming a colourless and very limp
liquid, and its yielding metallic arsenicum when dried and heated with
black flax, or a mixture of ignited carbonate of soda and charcoal.
When the quantity of sesquisulphuret is small, some difficulty may
Arsenious acid. 381

The faciliies of the hydrosulphuric acid test are, the salts of cadmium, persulphate of tin, the antimonial compounds, and selenic acid, which as the ammonium and precipitates with hydrosulphuric acid, more or less analogous in form to that produced by arsenious acid. The precipitate with cadmium closely resembles that with arsenic. This metal (cadmium) has been introduced in some of the preparations of zinc (vide Thomson’s Hist. of mistry, ii. 220). The perchloride of tin, sold for the use of dyers by the name of spirit of tin, occasions a yellow precipitate (bisulphate of tin) somewhat resembling sesquisulphuret of arsenic. Very solutions of emetic tartar form a reddish yellow liquid, or throw in a reddish precipitate (sesquisulphuret of antimony) somewhat analogous in appearance to that formed by an arsenical liquid. If hydrosulphuric acid be transmitted through a liquid in which pulvis antimonii has been boiled, the solution acquires a yellowish red colour, from the formation of some sesquisulphuret of antimony. From all the precipitates sesquisulphuret of arsenicum is readily distinguished the reduction test already mentioned.

Arsenious acid (described at p. 271) is sometimes employed as a substitute for hydrosulphuric acid, an acid being added at time of applying it, to neutralize the ammonia; but it is liable to several serious objections. When fresh prepared, it causes a yellowish precipitate with arsenious acid, red with emetic tartar, and black with solutions of lead; but by exposure to the air for a day or two it forms a white precipitate with arsenious acid, yellow with emetic tartar, and red with lead.

Nascent Hydrogen: Marsh’s test.—If arsenious acid be submitted to the action of nascent hydrogen, it is deoxidized, and the metallic arsenic in the liquid obtained, combining with hydrogen, forms arseniuretted hydrogen gas.

This test, which is the discovery of Mr. Marsh, of Woolwich (Trans. of the Soc. of Arts, li. 66; also Lond. Med. Gaz. xviii. 650), may be thus carried out:—Mix a small portion of the suspected liquid with some diluted sulphuric acid (1 oil of vitriol and 7 water), and pour the mixture over the pieces of zinc previously introduced into a proper apparatus: bubbles of gas immediately make their appearance. If no arsenious acid be present, the evolved gas is hydrogen; but if the liquor hold arsenic in solution, arseniuretted hydrogen gas is formed. This gas is recognized by the following characters: it has an alliaceous odour, and burns in the air with a bluish white flame, and the deposition of black metallic arsenic and white arsenious acid. If a plate of mica, or of common glass, or of porcelain (as a white saucer), be held a short distance over the flame, arsenious acid, in a finely pulverized state, is deposited on it: if the plate be depressed so as to touch the flame, and thereby only to impede the combustion of the gas, a blackish deposit of metallic arsenic is obtained. Or both these deposits may be readily secured by holding vertically over the flame a tube of glass, 9 or 10 inches long, and a quarter or half an inch in diameter: the tube becomes red for the space of several inches with metallic arsenicum and
arsenious acid, and the garlic tube. To obtain solutions of
Fig. 62. & Fig. 61.

Fig. 62.—(g) Small glass bucket.

odour can be detected at either end of the acid, let the flame successively place beneath three or four drops of water place on the under side of a plate of mica; then apply the liquid tests for arsenic before mentioned (Herapath, Med. Gaz. xviii. 389).

Various forms of apparatus may be used for this experiment. That employed by Mr. Marsh is a simple glass tube, like a syphon (fig. 61). A bit of glass is dropped into the shorter leg, then piece of clean sheet zinc: the stop-cock and jet are afterwards to be inserted. To suspected liquid, mixed with the dilute acid before mentioned, is to be the poured into the long leg. Effervescence is produced, and after allowing the air to be expelled, the stop-cock is to be closed and when a sufficient accumulation of gas has taken place, it is again to be opened and the gas ignited. Where the mica to be examined is very small in quantity, Mr. Marsh puts the suspected liquid, the acid, and the zinc, in a little glass bucket (fig. 62), attached to the stop-cock by platinum wire, and then introduces it in the short leg of the syphon, previously filled with common water. A modification (fig. 63) of Mr. Marsh’s apparatus is supplied with two bulbs, one in each leg of the instrument, and presents some advantages over the simple syphon tube; thus it enables us to collect a larger quantity of gas, while the bulb assists in checking the frothing by breaking the bubble. But the simplest, cheapest, and often the most useful form of apparatus, is a two ounce wide-mouthed phial, with a copper perforated by a glass tube or tobacco-pip as in fig. 64, p. 383, annexed. It presents this great advantage, that we can employ fresh apparatus for every experiment, and thus avoid all possibility of contamination from arsenical liquids used in previous experiments.

The impediments to the operation of Marsh’s test are, organic liquids (as porto soup, contents of the stomach, &c.), while occasion great frothing, and choke up the jet. The means of obviating this are greasing or oiling the interior of the short leg of the apparatus, putting a layer
hol or oil on the surface of the liquid in the short limb, and placing apparatus aside for an hour or two, to allow the bubbles to burst.

The fallacy of the test is, that if a solution of emetic tartar be employed instead of an arsenical liquid, we obtain antimoniuiretted hydrogen gas, which coincides in many of its properties with arseniuiretted hydrogen (Mr. L. Thompson, _Lond. & Edinb. Phil. Mag._, May 1837). Thus it has a peculiar odour, not very unlike that of arseniuiretted hydrogen, and burns in the air with a pale bluish flame, and the deposition of metallic antimony and the white oxide (on mica or glass held over it), which resemble, in their general appearance, arsenicum and arsenious acid: moreover, the action of hydrosulphurie acid and of ammoniaco-sulphate of copper on the oxide of antimony, produces colours resembling those generated by the action of the tests on arsenious acid. The two metals may, however, be distinguished by adding a drop of nitric acid to the crusts, and evaporating to dryness: a white powder is left in each instance. A few drops of dilute solution of the nitrate of silver being now added, and the whole exposed to the fumes arising from a stopper moistened with ammonia, arsenical crust will give the well known canary-yellow flocculi (Mr. Thompson, _op. cit._) Moreover, the greater volatility of arsenicum, its conversion into octahedral crystals of arsenious acid (Dr. E. Turner's _Chemistry_, by W. Turner) may serve, in some cases, to distinguish from antimony. Furthermore, the solubility of the arsenious acid, and reaction of the before-mentioned liquid tests on the solution, will distinguish it from oxide of antimony, which is insoluble.

In performing Marsh's test great care must be taken that the apparatus is perfectly clean, and that fresh zinc and acid liquor be used for every experiment. The experimenter should be fully alive to the possibility of arsenic, zinc, or even the brasswork of the apparatus, containing minute traces of arsenic; hence the necessity of examining the qualities of the It has been shown by Mohr (_Journ. de Pharm._ xxiii. 563) that zinc which had been used, but afterwards carefully washed both in water and acid, retained sufficient arsenic to produce the usual effects on the hydrogen flame.

**Of Arsenious Acid in Organic Mixtures.**—I shall confine myself to a brief notice of the modes of detecting arsenious acid when mixed with the contents and tissues of the stomach, and must refer the reader to Dr. Christison _On Poisons_, and to his paper in the _Edinb. Med. & Surg. Journ._ xxii. 60, as well as to Devergie's _Méd. Lég._ ii. 718, for further details, especially in reference to other organic mixtures.

When the stomach is laid open we sometimes observe in it a white matter or white particles; these are, of course, to be carefully removed; if they be arsenious acid, no difficulty will be experienced in recognizing them by the tests already mentioned.

If no solid arsenious acid be observed, cut the stomach into small pieces, and boil it with the contents of this viscus for half an hour in dilute water, to which a small quantity of liquor potassae has been added: then filter, first through muslin, and afterwards through paper. Arsenious acid is insoluble in water, and, by boiling, albumen is coagulated, so
that (with the exception of small portions of these principles held in solution by the alkali) the filtered liquor is free from both fibrin and albumen. A little acetic acid is now to be added, and the liquid boiled by which any casein present will be coagulated, and got rid of by filtering a second time. Sometimes the liquor is now found sufficiently free from organic matters to enable us to detect the arsenious acid very readily by the ammoniaco-nitrate of silver. Dr. Christison says, that if this test act characteristically, that is, gives a copious yellow precipitate, the liquid is sufficiently free from foreign matter. If, however, it give no indication, or at least only imperfect ones of arsenious acid, evaporate to dryness by a gentle heat (as a water-bath), and boil the residue in repeated portions of distilled water. We thus obtain a solution of arse-
nious acid, which, after being acidulated with acetic or hydrochloric acid, is to be decomposed by passing a current of hydrosulphuric acid through it. The precipitated orpiment (sesquisulphuret of arsenic) is to be collected, and reduced in the way already described (p. 378).

Arsenious acid in organic liquids may sometimes be readily detected by the development of arseniuretted hydrogen when zinc and sulphuric acid are added to the suspected liquor (vide p. 381). But the frothing produced by the organic matter creates considerable difficulty. I have already pointed out the best methods of obviating it.

Composition.—The following is the composition of arsenious acid:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Berzelius.</th>
<th>Mitscherlich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenicum</td>
<td>1</td>
<td>38</td>
<td>76</td>
<td>75:782</td>
<td>75:73</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1/4</td>
<td>12</td>
<td>24</td>
<td>24:218</td>
<td>24:27</td>
</tr>
<tr>
<td>Arsenious Acid</td>
<td>1</td>
<td>50</td>
<td>100</td>
<td>100:000</td>
<td>100:000</td>
</tr>
</tbody>
</table>

Purity.—Powdered arsenious acid is sometimes adulterated with chalk or sulphate of lime. The fraud is readily detected by heat, which volatilizes the acid, but leaves the impurities.

Physiological Effects. (a.) On vegetables.—The effects of arsenious acid on plants have been studied by Jäger (Diss. Inaug. Tubingae, 1808 quoted by Marx in his Die Lehre von den Giften, ii. 99); Marcret Macaire, Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève t. iii.), and by others; and from their observations we learn that it is poisonous to all the higher and most of the lower families of plants. It appears that seeds which have been soaked in a solution of arsenious acid are incapable of germinating, and that buds which have been plunged in it are no longer capable of expanding. If roots or stems be immersed in this solution the plants perish; death being preceded by drooping and alteration of the colour of the leaves and petals. If the stem of the common barberry (Berberis vulgaris) be placed in dilute hydrocyanic acid, or in an aqueous solution of opium, the stamens lose their remarkable contractile power, but remain flexible. If, however, we employ a solution of arsenious acid, the plant equally dies, but the stamens become stiff, hard, and retracted, and on any attempts being made to alter their position, they readily break. These curious facts appear to prove that the effects produced by this acid on vegetables are very different from those caused by hydrocyanic acid and opium; for the latter seem to exhaust the irritability, while the former appear to give rise to a condition very analogous to the spasm of animals. Jäger has seen a small plant (supposed by Delcandolle, in his Phys. Vég. p. 1329, to be Mucor imperceptibilis) grow in
ter which contained \( \frac{1}{12} \) of its weight of arsenic. And, more recently, genkrantz (Journ. de Pharm. xxiii. 38) says he has seen an algaceous plant, of the genus either Leptomitus or Hygrocris, develop itself in a solution of arsenic. These are most remarkable exceptions to the general facts of this poison on vegetables, and deserve further examination. Ver has shewn that arsenic is absorbed by plants: for he found that on ming vegetables destroyed by this poison he obtained a garlic odour.

b.) On animals generally.—Arsenious acid is poisonous to all classes of animals. No exceptions, I believe, are known to exist to this statement. The most extensive series of experiments on this subject are those performed by Jäger (op. cit.) From them we learn that in all animals, from the infusoria up to man, death from arsenic is invariably preceded by inordinate actions and increased evacuations, especially from the mucous membranes. In most animals the stools were frequent and liquid, and in those in which mucus is secreted on the surface, it was remarkably increased. The power of voluntary motion and susceptibility to external stimuli were decreased; and after death the muscles soon ceased to be influenced by the galvanic agency. In animals which ate by lungs, respiration became difficult and laborious; and in m-blooded animals great thirst was experienced. In birds and mammals convulsions came on, preceded by vomiting, except in those animals (the rabbit) which cannot vomit. Enormous quantities of arsenious acid have been sometimes administered to horses with impunity. Bertheau de Méd. Vét. Oct. 1825) gave 2 and afterwards 3 drachms to a horse, for the cure of an obstinate skin disease, without any injurious effects. Beissenhirz (quoted by Wibmer, die Wirkung, &c. i. 317) gave successively, on different days, 1, 4, 3, 2, and 8 drachms of arsenious acid to a horse: the animal did not die until the ninth day after taking the mentioned dose. Yet notwithstanding these and some other analogous facts, which seem to prove that arsenic has comparatively little effect on horses, the best informed veterinarians agree in considering it an acute poison to these animals. (See the evidence of Mr. Bowles, in Med. Med. and Surg. Journ. viii. 351.)

c.) On man. a. Of very small or therapeutical doses.—In very small quantities (as \( \frac{1}{12} \) or \( \frac{1}{12} \) of a grain) no obvious effects are usually produced by the use of arsenic, unless it be continued for a long period. Indeed the writers (e. g. Vogt, Pharmacodyn.) go so far as to assert that it is arefreshing remedy, and that it improves the appetite, invigorates digestion, promotes assimilation and secretion, excites the muscular and nervous functions,—in a word, acts as a tonic. I cannot, however, subscribe to this doctrine, because I have never been able to see the effects asserted. It is, indeed, true that patients sometimes experience a temporary increase of appetite from the use of small doses of arsenic; and it is also certain that this remedy is frequently beneficial in agues and diseases in which tonics have been found efficacious. But the analogy between the action of arsenious acid and that of the vegetable albes (as cinchona, to which Vogt compares it) stops here. I have sought in vain for other evidences of a tonic operation. I have seen minute doses of arsenic given to patients affected with lepra, and continued for many days, without being able to detect the least indication of action on the system, except the amelioration of the disease. When
the dose was slightly increased, the appetite in some cases appeared to
be increased; but this effect was neither universal nor continued. Very
shortly afterwards, a sensation of heat in the throat, oesophagus, and
stomach, came on, occasionally with nausea, but seldom with vomiting:
in a few cases with gastrodynia; a febrile condition of the body was set
up; there were dryness of the skin, increased secretion of urine, relaxed
bowels, sometimes with griping; the patients usually complained of great
languor, inaptitude for employment, and want of sleep; and sometimes
these symptoms were accompanied with, or followed by, redness of the eyes
and certain swellings especially of the face, (edema arsenicalis)—effects
which are so different from those produced by the remedies called
strengthening, that I cannot regard arsenic as a tonic. In proof of the
beneficial effects of this substance; we are gravely told that the country
people of Upper Styria, in Austria, use arsenic as a stomachic, and con-
diment for many kinds of food—for example, cheese; and a healthy
peasant himself tells us that he was accustomed to take two grains of
arsenic daily, without which, he assures us, he could not live! (Med.
Jahr. d. österr. Staates. 1822, i. 99, quoted from Wibmer.) In further
proof of this strengthening action of arsenic, Vogt says that it promotes
the appetite, the activity, and the power of old enfeebled horses, and
mentions that Jäger noticed the same effects on a pigeon. To the first of
these statements, namely, the beneficial effects from the use of arsenic as
a condiment, I confess I do not give credence; and with respect to the
action of arsenic on horses, every well-informed veterinarian knows that
it operates on these animals as a virulent poison.

Dr. Fowler (Med. Reports of the Effects of Arsenic, p. 98) gives the
following summary of the effects of the arsenical solution in more than
320 cases:—In about \( \frac{1}{4} \) no operation; "somewhat more than \( \frac{1}{4} \) were
attended with nausea; and nearly \( \frac{3}{4} \) with an open body; and about \( \frac{1}{2} \) with
vomiting. Vomiting, purgings, swellings, and anorexia, were but rare in
comparison with the preceding effects, and their less frequent occurrence
were generally found in the order in which they are here enumerate:
swellings and anorexia being the seldomest. About \( \frac{1}{3} \) of the cases attended
with nausea, and \( \frac{1}{3} \) of those attended with an open body, were unconnected
with any other effects. Griping did not often occur alone; purging and
anorexia seldom or never; and vomiting was always accompanied with
more or less nausea." In some cases salivation has been produced by the
medicinal use of arsenic, as will be noticed presently.

B. Of long-continued small doses, or of large medicinal doses (slow
chronic poisoning.)—If the use of small doses of arsenious acid be con-
tinued for a long period, it acts as a slow poison; and if persevered in, will
ultimately occasion death. The same effects take place, in a short
period, from the administration of large medicinal doses. Sometimes the
digestive apparatus, at other times the nervous system, first shews sym-
toms of the poisonous operation of this agent.

Hahnemann (quoted by Dr. Christison) has graphically described the
condition of slow poisoning by arsenic as "a gradual sinking of the
powers of life, without any violent symptom; a nameless feeling of
weakness, failure of the strength, an aversion to food and drink, and all the
other enjoyments of life."

On some occasions the first symptoms which I have observed of this
poisonous operation have been thirst, redness of the conjunctiva an
lids, followed by a cutaneous eruption. At other times irritation of the mucous membrane is the leading symptom. In some cases ptomaines are produced on the surface of arsenious acid, as also Dr. Ferriar (Ephem. Med. Gaz. xvi. 1809). Mr. Furley (Lond. Med. Gaz. iii. 306.) has published five illustrative cases of it. Trousseau and Pidoux (Traité de pharmac. ii. 148) also mention this symptom as produced by the long-continued use of feeble doses of arsenic. This effect acquired some importance in the celebrated Bristol case of poisoning. (Lond. Med. Gaz. 1809, ii. 519, and Trans. Proc. Assoc. iii. 432.)

The following is an abstract of the symptoms produced by the long-continued employment of small doses of arsenious acid, but which are either or less modified in different cases:—Disorder of the digestive functions, characterized by flatulence, sensation of warmth, or actual pain, in the stomach and bowels; loss of appetite; thirst, nausea, and vomiting; itching, or at least a relaxed condition of the bowels, and griping; furrowed face, with dryness and tightness of the mouth and throat, or with salivation. The pulse is quick, small, and sometimes irregular; respiration oppressed, and accompanied with a dry cough. The body wastes; the face becomes frequently so irritable that no food can be retained in it. Headache, giddiness, and want of sleep, are frequently observed. The eyes become painful, feeble, trembling, subject to convulsions; occasionally benumbed, and ultimately paralyzed. The cutaneous system is affected in some cases, affected, an eruption makes its appearance, and now and then the hair and nails fall off. Swelling of the feet and of the face is uncommonly observed; and under these symptoms the patient gradually sinks, in some cases retaining his consciousness to the last, but at other times delirium and stupor supervening.

Of excessive or poisonous doses (acute poisoning.)—The symptoms produced by the ingestion of a large dose of arsenious acid are not invariably alike, but put on three forms. In some cases the principal or leading ones are those indicating gastro-enteritis; the nervous system being not obviously, or at least only slightly, affected. In others, gastro-enteritis symptoms are absent, and the principal operation of the poison is on the vascular and nervous systems. Lastly, there are other cases in which we have both gastro-enteritis symptoms with an action of the nervous and vascular systems.

Form 1st: Acute poisoning with symptoms of gastro-enteritis.—In this form of arsenical poisoning, nausea and vomiting come on soon after the poison has been swallowed, and are attended with burning pain in the chest and stomach, and which soon extends over the whole abdomen. Thirst and vomiting, however, are not invariably present. The matters vomited vary in their nature and appearance; sometimes being bilious, other times tinged with blood. Frequently there is a sense of heat, pressing, tightness, and constriction of the throat, accompanied with an insatiable thirst, and occasionally with an almost hydrophobic difficulty in swallowing. The lower part of the alimentary canal soon becomes irritated, indicated by the burning pain, which is increased on pressure—the hard and tense condition of the abdomen—by the diarrhœa (the stools occasionally being bloody)—by the tenesmus—and by the ocular heat and excretion of the anus. When the lower part of the alimentary canal is powerfully irritated, the urino-genital apparatus becomes affected; and thus there may be difficulty in passing the water, a burning pain in the genital organs. The constitutional symptoms
are, in part, such as might be expected from this violent local disorder: thus, the pulse is quick, but at the same time small, feeble, and irregular; there are cold clammy sweats; the action of the heart is irregular, giving rise to palpitation; the breathing is short, laborious, and often painful; the tongue is dry and furred; and the membrane lining the air passages feels hot, and oftentimes painful.

Although, in this form of acute arsenical poisoning, the gastro-enteritis is the principal, and in some cases almost the only affection, yet there are generally observed some symptoms indicative of disorder of the cerebro-spinal system: sometimes in the form of tremblings or cramps of the limbs, or delirium, and even, in the last stage, insensibility. Occasionally, also, eruptions take place.

In this form of poisoning, death usually occurs in from twenty-four hours to three days after the administration of arsenic; but Dr. Christison says that PyI has recorded a case where death occurred in three hours after swallowing the poison.

Form 2d: Acute poisoning with narcotism, without any remarkable symptoms of gastro-enteritis.—In some cases of poisoning, in both man and animals, the symptoms are those indicating disorder of the cerebro-spinal and vascular systems: abdominal pain, vomiting, and purging, being either altogether absent or very slight. The symptoms are usually faintness, or perhaps actual syncope, convulsions, or paralysis; and sometimes, insensibility; at other times, delirium. These symptoms constitute the state called narcotism. Of this form of arsenical poisoning (which is somewhat rare) Dr. Christison has given an abstract of twelve recorded cases. In most of them the quantity of arsenious acid taken was very large; for example, half an ounce, or even an ounce.

Form 3d: Acute poisoning with symptoms of gastro-enteritis, followed by an affection of the cerebro-spinal system.—In this form of poisoning we have at first the usual gastro-enteritic symptoms, and which I have already described under the first form of poisoning. When, from the smallness of the dose, or from other circumstances, the patient recovers from the gastro-enteritis, symptoms of a cerebro-spinal affection sometimes make their appearance. The kind of disorder, however, varies considerably in different individuals. "The most formidable," says Dr. Christison, "is coma; the slightest, a peculiar imperfect palsy of the arms or legs, resembling what is occasioned by the poison of lead; and between these extremes have been observed epileptic fits, or tetamors, an affection resembling hysteria, or madness."

In a medico-legal point of view it is important to determine what is the smallest fatal dose of arsenious acid. It is not easy, however, to give a positive answer to this question. Dr. Christison says, "the smallest actually fatal dose I have hitherto found recorded is ½ grains. The subject was a child four years old, and death occurred in six hours. In this instance, however, the poison was taken in solution." The powerful effects sometimes produced by ⅔, ¼, or ½ a grain, lead us to suspect that 1 grain might produce death; but we have no recorded case of this. Hahnemann says, 1 or 2 grains may prove fatal in a few days; and Dr. Christison remarks, that this statement cannot be very wide of the truth. Of course a repetition of much smaller quantities might cause death. However, under certain circumstances, enormous quantities have been swallowed with very trivial effects. Some years ago I opened the body of a man who destroyed himself by taking arsenic, and I was informed
the friends that about a fortnight previous to his death, he made an
empt to destroy himself by swallowing a quantity of powdered arsenic,
ich they found, on inquiry at the druggists of whom it was purchased,
have weighed half an ounce. It was taken immediately after dinner,
all the only effect produced was violent vomiting. Here it is evident
that the distension of the stomach with food saved the patient’s life.
It is unfortunate individual repeated the attempt, and death was the result.

A. Morbid appearances produced by Arsenious Acid.—When arse-
nious acid kills by its narcotic operation (constituting the second form of
ical poisoning), no morbid condition is observable after death. In
er cases, however, various alterations are observed, which may be
veniently arranged under the following heads:
1.) Morbid appearances of the alimentary canal.—The alterations ob-
red in the condition of the intestinal canal vary with the quantity of
ison taken, and probably with other circumstances, but they are all
ative of inflammation: thus we have redness as one symptom, some-
es accompanied with extravasations of blood into the tissue of the
al; ulceration is also frequently observed, sometimes softening of the
ous coat, effusion (of lymph or blood), and occasionally even gan-
ous spots.

2.) Morbid appearances of the vascular system.—The blood is some-
es, though not invariably, fluid after death, and dark coloured. The
art is mostly flabby, and it is asserted that on its inner surface (es-
ly the carnea columnae and valves, particularly of the left side),
erved redness, sometimes diffused, sometimes in the form of spots,
which penetrates a line in depth into the substance of the heart.
pericardium usually contains serum.

3.) Morbid appearances of the respiratory system.—These are neither
remarkable nor constant, and principally consist in redness of the
ara, effusion of lymph or serum into the cavity of the pleura, red spots,
occasional congestion of the lungs, and redness of the membrane
ng the air tubes.

4.) The morbid appearances of other parts deserve little attention.
some cases inflammation, and even gangrene, of the genital organs
been observed; the conjunctiva is sometimes very vascular, and
ations are occasionally observed in the condition of the skin. Red-
 extravasation of blood, and effusion of serum, are said to have been
in the brain.

In connexion with the morbid appearances produced by arsenic, the fol-
ing remarks, made by Orsila (Dict. de Méd. ed. 2, art. Arsenic) deserve
ce. "Under certain circumstances the mucous membrane of the sto-
th and intestines is lined with a multitude of brilliant points, composed
at and albumen: placed on burning coals these grains decrepitate on
ng, and produce a noise which has been improperly denominated
ation: they inflame as a fatty body when they contain a notable
ity of fat, and exhale an odour of burned animal matter. These
and albuminous globules may be met with in the bodies of indivi-
ds who have not been poisoned, and require attentive examination ;in
er to distinguish them from arsenious acid. The best method of
avoiding this error is to digest these granular parts with water, and to apply the tests proper for demonstrating the existence of arsenious acid."

Influence of Arsenious Acid on the Putrefactive Process.—Until the commencement of the present century it was supposed that the bodies of animals poisoned by arsenious acid were unusually prone to putrefaction. This, however, has been satisfactorily disproved by the experiments and observations of Klank, Kelch, Hülnefeld, and others (quoted by Wibmer, in his Wirkung d. Arzneim. u. Gifte; and by Dr. Christison in his Treatise on Poisons); and it appears, that when placed in contact with animal textures, it acts as an antiseptic. "I have kept a bit of ox's stomach four years in a solution of arsenic," says Dr. Christison, "and except slight shrivelling and whitening, I could not observe any change produced in it." This antiseptic property of arsenious acid, which has been, in my opinion, fully and satisfactorily proved, sufficiently accounts for the good state of preservation in which the alimentary canal has been frequently found some months after death in those poisoned by this acid where it was not evacuated by vomiting or purging.

But there is another effect said to be produced on the bodies of animals, which is not so easily accounted for: I mean their conversion into a kind of mummy-like or adipocirous matter. The following is an abstract of the phenomena, as deduced from numerous experiments and observations, several of which are recorded in Dr. Christison's invaluable Treatise. After death putrefaction commences, and is attended with the usual odour; but, instead of increasing in the customary manner, it seems for a time to be at a stand-still, and then a series of changes commences of a peculiar character: the soft parts become firmer and drier, at the same time retaining their structure; the putrid odour is frequently succeeded by one resembling garlic; the skin becomes brown and parchment-like; the muscular fibres and cellular tissue (especially of the abdominal parieties) are changed into a tallowy cheesy-like mass the liver, spleen, and heart, become dry, while the bowels, lungs, and brain, form a greasy mass. During these processes it is said that the quantity of arsenic diminishes, probably by exhalation,—a circumstance very probable, when we bear in mind the garlic odour emitted by the body, and which has been observed by several writers. The diminution however, must be exceedingly small. After some time the cheesy smell disappears, and the body becomes dry and hard. In some cases the alimentary tube has been found little changed or decomposed, although other parts of the body had been completely mummified.

I ought, however, to remark, that some writers do not ascribe these phenomena to the influence of arsenious acid, but to other causes. Jäger (quoted by Wibmer, op. cit. i. 305) tells us that in his experiments the putrefaction of the bodies of animals poisoned by arsenic seemed neither to be retarded nor hastened, whether they were buried or not; but he admits that parts in contact with an arsenical solution seem preserve from putrefaction. Seemann (quoted by Dr. Christison, op. cit. p. 322; also Wibmer, op. cit. i. 322) likewise states, that the bodies of three dogs underwent the usual kind of putrefaction after death. However, that in many cases arsenic modifies the putrefactive process, can hardly, I think, be doubted by those who carefully examine the evidence adduced in favour of this opinion.

Does this mummifying process depend on the chemical influence of the
Arsonous acid, or ought we to refer it to a change effected by arsenic on the body, during life, causing "a different disposition and affinity among the mate elements of organized matter, and so altering the operation of the laws in it?" The latter hypothesis, though advocated by Dr. Christison, appears to me untenable; for, in the first place, there is no evidence of any peculiar change of this kind during life; secondly, that does not take place appears probable, from the putrefactive process commencing after death as usual; and it would appear that the peculiar essence of the arsenic does not commence, or at least is not evident, till this process has existed for some time, and when a garlic odour is given by the body. It is, indeed, true that the quantity of arsenous acid has been detected in the body after death, is, as Dr. Christison marks, "almost inappreciably small;" but it is probable that the entity is much larger than chemists have yet been able to recognize; but it is not at all unlikely that the arsenious acid may enter into new combinations while within the dead body, and in this way become diffused, probably in a gaseous state: the garlic odour which is evolved from this notion, as well as the statement made by some, that the entity of arsenic in the body diminishes during the progress of the putrefactive process.

Modus Operandi.—When we consider that arsenious acid operates as poison to whatever part of the body it be applied, the nerves and muscular fibres excepted; that the quickness with which it acts is in proportion to the absorbing powers of the part, and that the most soluble of the most energetic preparations, we can have little difficulty in admitting that absorption into the blood-vessels is necessary to the action of this potent agent. But the detection of arsenic in the solids and fluids of the body has hitherto not been effected in a satisfactory manner. Lassaigne (quoted by Wibmer, op. cit. i. 321) states, that he detected it in the infiltrated pleura of a horse; and Fodéré (quoted by Dr. Christison) twice got indications of its presence in the urine: but Hardegg and Schubarth, on the other hand, failed to recognize it, and therefore other evidence of its existence in the body is necessary, to enable us to have confidence in the results of Lassaigne and Fodéré. An acquaintance of Beissenhirz (quoted by Wibmer, op. cit. i. 318) obtained nearly pure grains of metallic arsenic from the stomach, cæcum, lungs, liver, heart, and brain of a horse poisoned by six drachms of arsenious acid, taken at divided doses: but the extraction of this substance from the mæch and cæcum is no evidence of its absorption.

Arsenious acid appears to exercise a specific influence over several parts of the body, especially the alimentary canal, the heart, and the nervous system. That the alimentary canal is specifically affected is shown by the inflammation of the stomach, induced by the application of arsenic to wounds, and which, according to Sir B. Brodie (Phil. Trans. for 1812, 209), is more violent, and more immediate, than when poison is taken into the stomach itself. That the heart is also specifically acted on by arsenious acid is proved by the symptoms (the anxiety at the precordia, the quick irregular pulse, &c.), and by the post-mortem appearances (red spots in the substance of this viscus), and by the diminished susceptibility to the galvanic influence. The specific action of the nervous system is inferred from the symptoms: thus, the headache, giddiness, wandering pains, impaired sensibility of the extre-
mities, and delirium or coma, are indications of the cerebral affection; while the feebleness, lassitude, trembling of the limbs, and the paralysis or tetanic symptoms, are evidences of the disordered condition of the true spinal or excito-motory system of Dr. Hall.

The alimentary canal, heart, and nervous system, are not the only parts on which this acid appears to exercise a specific influence: the lungs, the skin, the salivary glands, &c. are also specifically affected. The disorder of the lungs is inferred from the local pain, cough, and occasional inflammatory appearances after death. The eruptions and other altered appearances of the skin, and the falling off of the hair and nails (sometimes noticed), have led to the idea of the specific influence of arsenious acid on the cutaneous system,—an opinion which seems further supported by the fact of the remarkable influence it exercises in some cutaneous diseases, especially lepra. The salivation noticed by Marcus, Ferrier, Mr. Furley, Cazenave, and others, seems to shew that the salivary glands are sometimes specifically influenced. The swelling of the face, and the irritation and redness of the eyelids, also deserve notice in connexion with the specific effects of this poison.

Uses.—So powerful a poison as arsenic necessarily requires to be employed with great caution, and to have its effects carefully and attentively watched; for it has on more than one occasion proved fatal when used as a medicinal agent.

In intermittent fevers and other periodical diseases, arsenic has been employed with great success. For its introduction into practice in these cases in this country, we are indebted to the late Dr. Fowler, of Stafford (Med. Rep. of the Effects of Arsenic, 1786); but Lemery and Weiper appear to have first mentioned its febrifuge property. Dr. Fowler was led to its use from the beneficial effects obtained by the use of the "Tasteless Ague Drop," and from the information of Mr. Hughes, that this patent medicine was a preparation of arsenic. The reports published by Dr. Fowler, of the good effects of arsenic in periodical diseases, as observed by himself, by Dr. Arnold, and by Dr. Withering, have been amply confirmed by the subsequent experience of the profession generally. No remedy has been more successful in the treatment of ague. It will not unfrequently put a stop to the disease, even when cinchona or the sulphate of quinia have failed. Dr. Brown (Cyclopedia of Practical Medicine, ii. 228) who has used it in many hundreds of cases, never saw any permanently ill effect arise from it: he considers it superior to crude bark, but inferior to quinia: over both it has the advantages of cheapness and tastelessness. It should be given three times a day. It is not necessary to intermit its use during the febrile paroxysm, for I have repeatedly seen it given with the best effects during the attack. In agues, accompanied with inflammatory conditions, in which cinchona and sulphate of quinia are apt to disagree, arsenic may, according to Dr. Brown, be sometimes administered with the best effects. It is also very successful in relapses after the use of the above remedies. Dr. Macculloch (An Essay on the Remitt. and Intermitt. Diseases, 1828) states that \( \frac{1}{8} \) of a grain of white arsenic given three or four times a day will sometimes cure ague when the liquor potassae arsenitis fails. A combination of arsenic and cinchona, or arsenic and sulphate of quinia, sometimes succeeds, where these agents used separately fail. When the stomach is very irritable, opium is occasionally advan-
Arsenic is conjoined with arsenic. If the bowels be confined during the use of the remedy, gentle laxatives should be employed. Arsenic has beneficially employed in various other periodical diseases, as per
dical headaches, intermittent neuralgias, &c.

In various chronic affections of the skin, particularly the scaly diseases (pra and psoriasis), eczema, and impetigo, arsenic is one of our most useful agents. I can confidently recommend it in lepra, having seen a large number of cases treated by it without a single failure. Frequently the disease is relieved without any obvious constitutional effect: sometimes the condition of the body is brought on, with a slight feeling of it in the throat, and thirst; occasionally with an augmentation of the urine and cutaneous secretion often promoted; the bowels may be constipated or relaxed, and occasionally, as I have already noticed, salivation takes place. If the patient complain of swelling and pain about the face, or itching of the eyelids, the use of the medicine ought to be immediately suspended. Ichthyosis and elephantiasis are less to have been benefited by the use of it. (For further information on the use of arsenic in skin diseases, consult Rayer, Treatise on cases of the Skin, by Dr. Willis, p. 80.)

Various chronic affections of the nervous system have been treated by arsenic acid, and with occasional benefit: for example, neuralgia, lepsy, chorea (Dr. Gregory, Med. Chirurg. Trans. of London, xi. 299), even tetanus. I have seen arsenic used in a considerable number of lepetic cases, and in none was the disease cured. In some the fits occurred less frequently, but I am not sure that this was the effect of medicine. In chorea, I have seen advantage now and then accrue in the use of this agent. It has also relieved angina pectoris.

In bites of venomous snakes and of rabid animals, arsenic acid has been recommended. In India, the Tanjore pill (the basis of which is arsenic acid) has long been celebrated for the cure of the bite of the cobra di Capello, and other venomous serpents. Arsenic has been employed as an internal agent in various other diseases—as chronic rheum
tism, especially when attended with pains in the bones; in diseases the bones, particularly veneral nodes (Colhoum and Baer, Amer. Med. J. ord. iii. & iv.); in syphilis; in passive dropsies; in the last stage of Taus (Ferrier, Med. Hist. i. 84).

Arsenic acid has long been employed as an external application. Withstanding that it has been applied and recommended by Sir A. Duper, Dupuytren, and other high authorities, some doubt may be fairly entertained as to the propriety of its use, especially as in most, if not in instances, we may derive equal advantage by the employment of other dangerous applications. M. Roux, a celebrated surgeon at Paris, (Novv. Élém. de Méd.) that he amputated the breast of a girl 18 years of age, on account of a scirrhus of considerable magnitude. After amputation had been several days completed, ulceration commenced, accompanied with darting pains. To avoid frightening the girl by the use of the actual cautery, he applied an arsenical paste over a surface of an inch in diameter. Colic, vomiting, and alteration of counte
tence, came on the next day, and in two days afterwards she died in convulsions. "I am convinced," says M. Roux, "that this girl was poisoned by arsenic." I could quote several other cases illustrative of the same fact, but shall content myself with referring to Wibner's...
work (Die Wirkung. &c.) for an account of them. The following case, related by Desgranges (Orfila's Toxicol. Gén.) shews the danger of applying arsenic externally, even when the skin is sound:—A chamber-maid rubbed her head with an arsenical ointment, to destroy vermin. Though the skin was perfectly sound, the head began to swell in six or seven days after; the ears became twice their natural size, and covered with scabs, as were also several parts of the head; the glands of the jaw and face enlarged; the face was tumefied, and almost erysipelatous. Her pulse was hard, tense, and febrile; the tongue parched, and the skin dry. To these were added exeruciating pain, and a sensation of great heat. Vertigo, fainting, cardialgia, occasional vomiting, ardor urine, constipation, trembling of the limbs, and delirium, were also present. In a day or two after, the body, and especially the hands and feet, were covered with a considerable eruption of small pimplles, with white heads. She finally recovered, but during her convalescence the hair fell off.

Though employed as a caustic, yet it produces no known chemical change in the animal tissues. Hence it is termed by some a dynamical caustic, in opposition to those acting obviously by chemical agencies. Mr. Blackadder (Observ. on Phaged. Gangren.) asserts that the danger of employing arsenic consists in not applying a sufficient quantity. A small quantity, he says, becomes absorbed, whereas a large quantity quickly destroys the organization of the part, and stops absorption. Arsenie has been extolled as a remedy for cancer. Justamond esteems it a specific. Various empirical compounds, which gained temporary notoriety in the treatment of this affection, owe their activity to either arsenious acid or the sesquisulphuret of arsenicum. But by the best surgeons of the present day it is never employed, because experience has fully shown that it is incapable of curing genuine cancer, while it endanger the lives of the unfortunate patients. It cannot, however, be denied that diseases resembling cancer have been much relieved, if not cured, by it, and that the progress of cancer itself has occasionally been somewhat checked by its use.

In some forms of severe and unmanageable ulceration, especially lupus or noli me tangere, arsenical applications are employed with occasional benefit, where all other local remedies fail. In such cases arsenic is not to be regarded as a mere caustic, for other, and far more powerful agent of this kind, are generally useless. It must act by substitution: that is, it sets up a new action in the part incompatible with that of the disease. The late Baron Dupuytren employed an arsenical dusting powder (composed of 99 parts calomel and 1 part arsenious acid) in lupus, not as an escharotic, but rather as a specific. Mixed with gum-water or with fat matters, it has been sometimes used as a paste or ointment. These applications are to be allowed to fall off spontaneously, and to be repeated five or six times. Sir A. Cooper (Lancet, i. 264) recommends an arsenic ointment (arsenious acid; sublimed sulphur, &a 3f.; spermaceti cerate, 3f.) to be applied, on lint, for 24 hours, and then to be removed. When the slough comes away, the ulcer is to be dressed with simple ointment, and will generally heal in a short time. Cazenave says he has seen arsenic applications used by Biett, and has himself employed them many times without having met with one instance of injurious consequences. The arsenical paste (arsenious acid, cinnabar, and burnt leather, made into paste with saliva or gum-water) is used where a powerful action
Arsenious acid, or sesquisulphuret of arsenic, is a constituent of
most of the preparations sold as depilatories; as Delacroix’s Poudre Subtile,
rich, according to Dr. Paris, consists of quicklime, sulphuret of
enic, and some vegetable powder. Such applications are exceedingly
dangerous.

ADMINISTRATION.—Arsenious acid may be administered, in substance,
doses of from one-sixteenth to one-eighth of a grain, made into pills,
the crumb of bread. In making a mass of pills, great care should be
taken that the arsenic be equally divided; for this purpose it should be
ill rubbed in a mortar with some fine powder (as sugar) before adding
the bread crumb. A much safer mode of exhibition is to give this
efficient remedy, in the form of solution, with potash (as the liquor potasse
arsenitis). But I have already mentioned, that Dr. Macculloch found
that arsenic more efficacious than this solution: and Dr. Physick, of the
United States, thinks “that they act differently, and cannot be substituted
one for another” (United States Dispensatory). Whether given in the
solid or liquid form, it is best to exhibit it immediately after a meal,
when the stomach is filled with food; for when given on an empty sto-
ach (as in the morning fasting), it is much more apt to occasion gastric
order. It is sometimes advisable to conjoin opium, either to enable
the stomach to retain it, or to check purging. In debilitated constitu-
tions, tonics may be usefully combined with it. An emetic (as ipecac-
ahu), or a laxative (as rhubarb), may be employed where the stomach
overloaded, or the bowels confined. Its effects are to be carefully
watched, and whenever any unpleasant symptoms (as vomiting, griping,
gurgling, swelling or redness of the eyelids, dryness of throat, ptalysis,
tremors, or tremors) make their appearance, it will of course be advisable
diminish the dose, or suspend for a few days the use of the remedy.
Indeed, when none of these symptoms occur, it is not proper to continue
use more than two weeks without intermittting its employment for a
day or two, in order to guard against the occasional ill consequences
resulting from the accumulation of the poison in the system.

II. Liquor Potassae Arsenitis, Ph. Lon. & U.S.; solutio arsenicalis,
in the mineral solution (arsenious acid, carbonate of
potash, & gr. lxxx.; compound tincture of lavender, 5v.; water, 5xx.) The
arsenious acid and carbonate of potash are to be boiled, with the water,
in a glass vessel: arsenite of potash is formed, and carbonic acid evolved;
but the quantity of carbonate of potash is not sufficient to saturate the
acid. The compound tincture of lavender, which is used as a colouring
and flavouring ingredient, is to be added to the solution when cold, and
 afterwards more distilled water, to make the whole amount exactly to a pint;
and, twenty ounces). The dose of this solution is four or five minims,
usually and cautiously increased. I have known 15 minims taken
three times a day for a week, without any ill effects. Dr. Mitchell, of
Edin., has given from 15 to 20 drops, three times a day, in intermittents
United States Dispensatory). But as some persons are peculiarly sus-
tceptible of the influence of arsenic, we ought always to commence with
small doses. It has been given to children, and even pregnant women.

Dewees (Philadelphia Journ. of Med. & Phys. Sc. xiv. 187) adminis-
tered it successfully to a child only six weeks old, affected with a severe tertian ague. Dr. Fowler (Med. Rep. of the Effects of Arsenic) drew up the following table of doses for patients of different ages:

<table>
<thead>
<tr>
<th>Ages</th>
<th>Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 2 to 4 years</td>
<td>from 2 or 3 to 5 drops.</td>
</tr>
<tr>
<td>5 — 7</td>
<td>7</td>
</tr>
<tr>
<td>8 — 12</td>
<td>10</td>
</tr>
<tr>
<td>13 — 18</td>
<td>12</td>
</tr>
<tr>
<td>18, and upwards</td>
<td>12</td>
</tr>
</tbody>
</table>

But it may be remarked, that the quantities here indicated are larger than it will be safe, in most cases, to commence with.

The liquor arsenicalis of the Dublin Pharmacopoeia is one-sixteenth weaker than the corresponding preparation of the London and Edinburgh Pharmacopoeia.

2. Ceratum Arsenici, Ph. U. S. (arsenious acid, $\text{ars}_{2}$; simple cerate, $\text{ars}_{2}$). This preparation, which is used as a dressing to cancerous ulcers, should be employed with great circumspection.

Antidotes.—In cases of poisoning by arsenic, the first object is to expel the poison from the stomach. For this purpose the stomach-pump should be immediately applied. If this be not in readiness, and vomiting has not commenced, tickle the throat with a feather or the finger and administer an emetic of sulphate of copper or sulphate of zinc. Promote vomiting by diluent and demulcent liquids; as milk, white of egg and water, flour and water, gruel, sugared water, and broths. Charcoal, magnesia, and other inert powders, when swallowed in large quantities, may be occasionally of service, by enveloping the particles of arsenic, and preventing their contact with the gastric surface. Olive oil on which, according to Dr. Paris (Pharmacologia), the Cornish miners rely with confidence, can only act mechanically in the way just mentioned.

Hydrated sesquisoxide of iron was proposed, in 1834, by MM. Bunsen and Berthold, as an effectual chemical antidote (Journ. de Pharm. xx 567). Its efficacy was confirmed by the experiments of Souberein and Miquel (Journ. de Chim. Méd. i. 25. Ser. p. 3); of Orfila and Lesueur (ibid. p. 45); of Bouley, jun. (ibid. 46); and of Borelli and Demaria (ibid. p. 398), as well as by some cases of arsenical poisoning in the human subject, in which this remedy was employed (Journ. de Pharm. xxi. 98 & 681; Lond. Med. Gaz. xvi. 447; xvi. 832; and xix. 177). To be efficacious it must be given in very large doses; and when the poison has been swallowed in a solid form, 15 or 20 drops of liquor ammonia should be conjoined with each dose of the antidote, to transform the acid into a soluble arsenite, on which the oxide may act. It may also be exhibited in the form of enema. Hydrated sesquisoxide of iron may be procured by adding ammonia or potash, or their carbonates, to a solution of either of the nitrate of potassium (obtained by dissolving potassium in nitric acid over the fire in a pipkin), or of persulphate of iron (prepared by boiling a solution of the common sulphate of iron with nitric acid): the precipitate is to be washed with water, and swallowed undried. Mr. Brett (Lond Med. Gaz. xv. 220) denies the efficacy of the antidote, and states, moreover, that carefully prepared arsenite of iron is poisonous.

The subsequent part of the treatment of poisoning by arsenic consists in neutralizing or counteracting its effects, and which is to be effected on general principles, as we have no counter-poison. When the gastro
eritis is marked, our principal reliance must be on the usual antiphlo-
getic measures, particularly blood-letting, both general and local, and
stems to the abdomen. One drawback to the success of this treatment
the great depression of the vascular system, so that the patient cannot
port large evacuations of blood. Opium is a very valuable agent.
feed Jäger seems to regard it in the light of a counterpoison. How-
ver, on this point he has probably taken a too exaggerated view of its
ecy; but it is undeniable that on many occasions it is of great
ice. If the stomach reject it, we may employ it in the form of
sters. If constipation and tenesmus be troublesome, mild laxatives,
ially castor oil, should be exhibited.

*Arse'ni'ci Io'didum.—I'odide of Arsen'icu*m.*

This compound is prepared by gently heating, in a tubulated retort
sed in a sand-bath, a mixture of one part finely pulverized metallic
enicum and three parts of iodine: the iodide is afterwards to be su-
med, to separate the excess of arsenicium. The compound thus obtained
an orange-red solid, volatile, and soluble in water. If the solution be
idly evaporated to dryness, we reprocure the iodide; but if we con-
and then place the solution aside, white pearly plates are
ained, which by Plisson are regarded as a periodode of arsenicu*m, but
Serullas as a compound of oxide and iodide of arsenicu*m (Souberain,
Traité de Pharm. ii. 613; and Serullas, Journ. de Chim. Méd. iii.
). Iodide of arsenicu*m is probably composed of 1½ eq. iodine = 187.5,
1 eq. arsenicu*m = 38. It has been employed by Biett in the form
ment (composed of iodide of arsenicu*m, gr. ii.; lard, ʒ.) as an appli-
ion to corroding tubercular skin diseases (Magendie, *Formulaire*).

**Order 17. Compounds of Antimony.**

*Antimo'nii Sesquisulphure'tum.—Sesquisul'phuret of An'timony.*

**History.**—Black sulphuret of antimony was known in the most ancient
es, being used by the Asiatic and Greek ladies as a pigment for the
brows (2 Kings, ix. 30; Ezekiel, xxiii. 40; Pliny, Hist.Nat. xxxiii.)
was formerly called *stimmi* (στημμα vel στημε, stilbium (στηβί), or platy-
thalmon (πλατυθαλμόν), Dioscorides, v. 99.) In the native state it
ically termed *antimony ore*, and when fused out of its gangue, *crude
imony*, or *sulphuret of antimony*.

**Natural History.**—Sesquisulphuret of antimony is found native in
ious parts of the world, especially in Hungary, in the Hartz, in France,
wall, and in Borneo. From the latter place it is imported into
country by way of Singapore, being brought over as ballast to the
els. In the years 1835-36, and 37, the quantities of ore imported
respectively 645, 825, and 659 tons (Trade List, Jan. 10, 1837, and
, 1838).

**Preparation.**—The old method of separating the sesquisulphuret
its siliceous gangue was to melt it in a covered crucible or pot, in
bottom of which there are several holes, through which the fused sul-
ret passes into an inferior or receiving pot. According to Genseu*e's
thod, the melting pots are placed in a circular reverberatory furnace,
and are connected by curved earthen tubes with the receiving pots which are on the outside of the furnace. At La Vendée neither vessels nor tubes are used: the ore is placed on the bed of a reverberatory furnace, in which is an aperture to allow of the passage of the fused sesquisulphuret which flows into a receiving vessel placed externally to the furnace (Dumas, Traité de Chimie, iv. 160.)

Properties.—The fused sesquisulphuret (called common or crude antimony) occurs in commerce in roundish masses, called loaves or cakes; these when broken present a striated crystalline appearance, a dark steel or lead grey colour, and a metallic brilliancy. The commercial sesquisulphuret is opaque, tasteless, odourless, brittle, easily pulverizable, and has a sp. gr. of about 4.6. Its powder is black, but that of pure sesquisulphuret is reddish black. It is a little less fusible than metallic antimony. It is volatile but cannot be distilled, and it appears to be partially decomposed by heat, for when heated in an earthen crucible for an hour it loses from 10 to 20 per cent. of its weight (Berthier, Traité des Essais, ii. 490). By roasting it it is converted into antimony-ash or cinna antimonii (a mixture of antimonious acid and sesquisoxide of antimony) with more or less unburned sesquisulphuret: Liebig, Handwörterb. de Chemie, i. 419) and sulphurous acid, the latter of which escapes. When reduced to a very fine powder by levigation and elutriation it constitutes the antimonii sulphuretum preparatum of the Edinburgh, Dublin, and United States Pharmacopoeias.

Characteristics.—It fuses and is dissipated before the blow-pipe, with the smell of sulphurous acid and the formation of a white smoke. Digested in hydrochloric acid it evolves hydrosulphuric acid, and forms a solution of sesquichloride of antimony, which produces a whitish precipitate (powder of Algivroth, or oxychloruret of antimony) with water and an orange red one with hydrosulphuric acid. If a current of hydrogen gas be passed over heated sesquisulphuret of antimony, metallic antimony and hydrosulphuric acid gas are obtained: the metal decompose nitric acid and yields a white powder: it readily dissolves in nitrohydrochloric acid.

Composition.—Sesquisulphuret of antimony has the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Berzelius</th>
<th>Thomson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>1</td>
<td>65</td>
<td>73</td>
<td>72.8</td>
<td>73.77</td>
</tr>
<tr>
<td>Sulphur</td>
<td>1(^\frac{1}{2})</td>
<td>24</td>
<td>27</td>
<td>27.2</td>
<td>26.23</td>
</tr>
</tbody>
</table>

Sesquisulphuret of Antimony 1 89 100 100.0 100.0

Impurities.—The crude antimony of commerce is rarely, if ever, quite pure. It frequently contains the sulphurets of iron, lead, arsenicum, and copper, and on this account is not adapted for medicinal use. When pure it is completely soluble in hydrochloric acid: but when mixed with sulphuret of arsenicum this remains undissolved, and may be detected by reducing it with a mixture of charcoal and carbonate of soda (vide p. 378). If the hydrochloric solution be diluted with water (so as to precipitate the greater part of the antimony), and filtered, the presence of lead, iron or copper, may be determined by the appropriate tests for these metals hereafter to be mentioned.

Physiological Effects. (a.) On animals.—Rayer (Dict. de Méd. & Chir. Pratique. iii. 54) introduced half an ounce of it into the cellular
of the back of a dog; but no effects resulted from it. Fifteen grains
sed in the peritoneal sac caused inflammation, and in 24 hours death,
without any peculiar symptoms. Moiroud (Pharm. Vétér. 428) says,
given to horses, in doses of from 2 to 4 ounces, it acts as an
itant, causing increased frequency of pulse and respiration, and softer
als.

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b.) On man.—In most cases it produces no obvious effects, even when
in very large doses. Rayer (op. cit.) gave half an ounce of it in
order, for several days, without the slightest effect. Cullen (Treat. of
Med. ii. 482), however, has seen it cause nausea and vomiting in
or two instances in which it was largely employed. Rayer says
the decoction of the sesquisulphuret is much more active than an
tal quantity of the same preparation in powder. How are these facts
explained? Rayer ascribes the activity of the decoction to arse-
ac acid formed by boiling sulphuret of arsenicum (contained in the
ary crude antimony) with water; for Guibourt obtained in this way
\( \frac{1}{2} \) grs. of arsenious acid by boiling an ounce of crude antimony. But
sence of arsenic is not necessary to explain the greater activity of
decoction, since by long-continued boiling with water, the sesqui-
phuret of antimony yields hydrosulphuric acid and sesquioxide of
imony (Geiger, Handb. d. Pharm.) The occasional nausea and vomit-
ay arise from the decomposition of the sulphuret by the fluids in
alimentary canal.

Uses.—As a medicinal agent it is occasionally employed as a diaph-
and alterative in some skin diseases, especially lepra and scabies, in
ula and glandular affections, and in rheumatism and gout.

As a pharmaceutical and chemical agent it is a most important sub-
ce, being the source from which the metal, and all its compounds,
procured.

Administration.—The usual dose of it, when taken internally, is
en to thirty grains of the powder; but several drachms of it have
en taken without much effect. The tisan de Feitz, which is occasion-
ed in skin diseases, is prepared by boiling sarsaparilla, \( \frac{5}{2} \) j., and crude
imony (tied up in a bag) \( \frac{5}{2} \) j., in a pint and a half of water; then add
glass, \( \frac{5}{2} \) iv., previously dissolved in water, and reduce the whole (by
ging) to a pint, which is to be taken during the day (Rayer, Treatise on
seases of the Skin, by Dr. Willis, 1223).

Antimoni\( \text{ii} \) Sesquichlo\( \text{ridum}\).—Sesquichlo\( \text{ride} \) of Antimony.

History.—Basil Valenrène was acquainted with this preparation,
ch has had various appellations; such as oil or butter of antimony
um seu butterum antimonii\), muriate or hydrochlorate of antimony.
Preparation.—The impure hydrated sesquichloride, sold in the shops
butter of antimony, is usually prepared by dissolving roasted sesqui-
phuret of antimony (cinis antimonii) in hydrochloric acid, and adding
itate of iron to the solution as a colouring matter.

In the Dublin Pharmacopoeia an analogous compound is prepared (in
manufacture of the nitro-muriatic oxide of antimony) by digesting,
afterwards boiling, 20 parts of sesquisulphuret of antimony in a
ixture of 100 parts hydrochloric acid and 1 part of nitric acid. One
equivalent or 89 parts of sesquisulphuret of antimony require an equivalent and a half or 55.5 parts of hydrochloric acid for their complete decomposition: the products are, an equivalent and a half or 25.5 parts of hydrosulphuric acid, and one equivalent or 119 parts of sesquichloride of antimony. The nitric acid is employed to decompose the hydrosulphuric acid remaining in the liquor; this it does by converting the hydrogen into water, and precipitating the sulphur.

Pure sesquichloride of antimony is not used in medicine: its preparation need not, therefore, be described in this work.

**Properties.**—The butter of antimony of the shops is a transparent liquid, varying in its colour (which depends on the presence of iron) from yellow to deep red. Its specific gravity is 1.2 to 1.5. It fumes in the air (especially when ammonia is present), in consequence of containing an excess of hydrochloric acid. It reacts on vegetable colours as a powerful acid.

**Characteristics.**—Mixed with water it throws down a yellowish white powder called *powder of Algaroth*, or *mercury of life* (oxchlorure of antimony). The hydrosulphurets produce an orange-red precipitate alkalies a white precipitate (sesquioxide of antimony). Nitrate of silver occasions a white precipitate, composed of chloride of silver and sesquioxide of antimony: the latter is dissolved by digestion in hydrochloric acid.

**Composition.**—Sesquichloride of antimony is thus composed:

<table>
<thead>
<tr>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>1</td>
<td>65</td>
<td>54.62</td>
<td>54.98</td>
<td>53.27</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1/3</td>
<td>54</td>
<td>45.37</td>
<td>45.02</td>
<td>46.73</td>
</tr>
<tr>
<td>Sesquichloride Antimony</td>
<td>1</td>
<td>119</td>
<td>99.99</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

The butter of antimony of the shops contains *sesquichloride of antimony, free hydrochloric acid, water, and iron.* It may also contain other impurities derived from the sesquisulphuret from which it is directly or indirectly prepared. Serullas says he never found arsenic in it.

**Physiological Effects.**—It acts as an energetic caustic, but I am not acquainted with any cases of poisoning by it. It cannot be diluted without undergoing decomposition.

**Uses.**—In medicine it is employed only as a caustic. It usually acts without much pain or inflammation, and, after the separation of the eschar, produces a clean healthy surface. It is sometimes used as an application to parts bitten by rabid animals or venomous serpents: in liquidity enabling it to penetrate into all parts of the wound. It is also applied to ulcers to repress excessive granulations. Richter and Bee have employed it in staphyloma: the mode of applying it is as follows:—Dip a camel’s hair pencil, or a point of lint, into the liquid, and apply it to the tumor until a whitish crust is perceived, when the whole is to be immediately washed away by means of a larger pencil dipped first into milk and afterwards into milk and water.

**Antidotes.**—The treatment of poisoning by this preparation is the same as for the mineral acids (vide pp. 154 and 268.) After the use of antacids, vegetable astringents (tea and infusion of nutgalls) should be administered to neutralize the effect of the powder of Algaroth separately in the stomach. Gastro-enteritis is of course to be combated by the usual means.
Antimonii Oxysulphure'tum.—Oxysulphuret of Antimony.

History.—Basil Valentine (Triumphant Chariot of Antimony, by Kirringsius, p. 131) was acquainted with this preparation; and probably also knew the substance called Kermes mineral, though he does not mention it in his writings. Glauber, in 1658, and Lemery, in 1707, are both said to be discoverers of the latter substance; but it is hardly possible for Basil Valentine to have been unacquainted with it.

Natural History.—Kermes mineral, which is an oxysulphuret of antimony, though not identical with, yet nearly allied to, the preparation in the Pharmacopoeia, is found native in Saxony and other places: it is filled by mineralogists red antimony or native kermes.

Preparation.—If black or sesquisulphuret of antimony be boiled in an alkaline liquid, a solution is obtained which, on cooling, deposits a reddish powder called kermes mineral. If a dilute mineral acid be added to the filtered mother liquor, an orange red precipitate is produced, called the golden sulphuret of antimony. If the acid be added before the kermes is deposited, we obtain the orange red precipitate, called in the Pharmacopoeia oxysulphuret of antimony.

The oxysulphuret of antimony, Ph. L is prepared by mixing together 4 ounces of powdered sesquisulphuret of antimony, 4 pint of solution of potash, and 2 gallons of distilled water: boil for two hours, frequently straining, distilled water being often added, that it may fill the same measure. Strain the liquor, and gradually drop into it as much sulphuric acid as may be sufficient to throw down the oxysulphuret: then wash away the sulphate of potash with water, and dry what remains with a gentle heat.

Theory of the Process.—When sesquisulphuret of antimony and potash are heated together, the latter gives oxygen to the antimony, and potash to the sulphur of the sesquisulphuret; and thus sesquioxide of antimony and sulphuret of potash are produced. The sesquioxide combines with some undecomposed potash, forming hypo-antimonite of potash, and the sulphuret of potash with sesquisulphuret of antimony, forming a double sulphur salt: the antimonio-sesquisulphuret of potassium. These changes are explained in the subjoined diagram:

\[\text{Antimony}\rightarrow\text{Oxysulphuret of Antimony}\rightarrow\text{Sulphuret of Potassium}\rightarrow\text{Hypo-antimonite of Potash}\rightarrow\text{Sesquioxide of Antimony}\rightarrow\text{Potassium}\rightarrow\text{Oxygen}\rightarrow\text{Antimonio-sesquisulphuret of Potassium}\]

The solution contains free potash, the antimonio-sesquisulphuret of potassium, and part of the hypo-antimonite of potash. There is a dark, undissolved residuum (similar to crocus antimonii) composed of hypo-antimonite of potash and oxysulphuret of antimony: this is got rid of by filtering.

On the addition of sulphuric acid, sulphate of potash is produced by the combination of the acid with free potash,—with some potash formed by the union of the potassium of the sulphuret with the oxygen of some compounded water,—and with the potash of the hypo-antimonite. By these changes sesquisulphuret and sesquioxide of antimony are set free:
the whole of the first, and part of the second, precipitate. The hydrogen
of the decomposed water, with the sulphur of the sulphuret of potassium,
forms hydrosulphuric acid, a portion of which escapes in a gaseous form,
while the remainder, reacting on some sesquioxide of antimony, produces
water and sesquisulphuret, which are precipitated along with some
water of the solution. These changes will be better comprehended by
reference to the following diagram:

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphuric Acid</td>
<td>{Oxygen, Hydrogen} Water</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Antim.-Sesquisulphuret Potassium</td>
<td>Potassium. Sesquisulphuret of Antimony.</td>
</tr>
</tbody>
</table>

For further details respecting the theory of this process I must refer the
student to Berzelius's *Traité de Chimie*, ii. 501, and Liebig and Poggendorf's

**Properties.**—Oxysulphuret of antimony, Ph. L. is a bright red, odour-
less, almost tasteless powder. It is insoluble in cold water, and only
slightly soluble in liquor ammonia. Boiled in nitro-hydrochloric acid,
chloride of antimony is formed in solution, and some sulphur remains
undissolved. Heated in the air it burns, evolves sulphurous acid, and
leaves a greyish residuum.

**Characteristics.**—When heated with concentrated hydrochloric acid
it evolves hydrosulphuric acid, showing it to be a sulphuret. From the
other sulphurets or oxysulphurets of antimony it is to be distinguished
partly by its colour. Its hydrochloric solution is shewn to contain antimo-
y by the tests before mentioned for the sesquichloride of this metal
(*vide* p. 400.) When boiled in a solution of bitartrate of potash we
obtain a solution of emetic tartar, which may be recognized by the cha-
racters hereafter to be mentioned for this salt. It may be reduced by
hydrogen and heat (*vide* p. 409.)

**Composition.**—When boiled in a solution of bitartrate of potash, it
loses, according to Mr. Phillips (*Trans. 3d ed. 203*), 12 per cent.: the
amount of sesquioxide that it contains. Its composition, according to
the same authority, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Phillips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesquioxide Antimony</td>
<td>1</td>
<td>77</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Sesquisulphuret Antimony</td>
<td>5</td>
<td>445</td>
<td>75</td>
<td>76.5</td>
</tr>
<tr>
<td>Water</td>
<td>8</td>
<td>72</td>
<td>12</td>
<td>11.5</td>
</tr>
<tr>
<td>Oxysulphuret Antimony</td>
<td>1</td>
<td>594</td>
<td>100</td>
<td>100.0</td>
</tr>
</tbody>
</table>

But the sesquisulphuret and sesquioxide are probably only mechanically
mixed.

The commercial oxysulphuret is of a brighter colour than that ob-
tained according to the process of the Pharmacopoeia. A manufacturer
of it informs me it is prepared by boiling sulphur along with the sesqui-
sulphuret of antimony and potash, and precipitating by an acid in the
usual way.
Kermes antimonii consists of 2 equivalents of sesquisulphuret of antimony and 1 equivalent of sesquioxide of antimony (consequently it has the same composition as red antimony ore), and commonly contains also from 1 to 1 ¹/₄ per cent. of alkalii combined with sesquioxide of antimony. If continued washing with water the hypo-antimonite of potash and sesquioxide of antimony may be extracted, leaving the sesquisulphuret of antimony. (Liebig, Handwörterb. d. Chemie, t. 427.) Golden sulphuret of antimony is the persulphuret of antimony, and consists of 1 equivalent of antimony and 2½ equivalents of sulphur.

PURITY.—Recently precipitated oxysulphuret of antimony is readily and completely soluble in liquor potassae; but the oxysulphuret of the kermes leaves a white residuum. Boiled in hydrochloric acid, it is dissolved with the evolution of hydrosulphurie acid gas: the solution is alesecent or slightly milky, but becomes quite transparent on the addition of a small quantity of nitric acid. It should not effervesce with nitre sulphuric acid.

PHYSIOLOGICAL EFFECTS.—The medicinal activity of this preparation principally or wholly owing to sesquioxide of antimony; and as the quantity of this is probably inconstant, the preparation is uncertain in its operation. The obvious effects are precisely analogous to those of emetic tartar; namely, vomiting, purging, and sweating. In small doses it is employed as an alterative, expectorant, and diaphoretic: somewhat larger doses it causes nausea and sweating, and sometimes vomiting; in still larger quantities it excites both vomiting and sweating. (For some experiments and observations on the action of Kermes mineral and the golden sulphuret, consult Rayer, in Dict. de Méd. et Chir. art. iii. 57, et seq.)

USE.—It is principally employed as an alterative in chronic diseases, particularly cutaneous affections, glandular enlargements, secondary phthisis, rheumatism, and diseases of the liver. In these complaints it is usually associated with mercurials (especially calomel) and sometimes in guaiacum or narcotics. Kermes mineral has been employed as antiphlogistic in inflammatory affections of the respiratory organs, sometimes as an emetic.

ADMINISTRATION.—As an alterative the dose is from one to three or five grains: as an emetic from five grains to a suppository. It is a constituent of the pilulae hydrargyri chloridi compositae, Ph. L. (chloride mercury oxysulphuret of antimony, &amp; 5ii.; guaiacum resin, powdered, 3ss.; zelc., 5ii.) commonly termed Plummer's pill, the dose of which is from ten to twenty grains.

ANTIDOTES.—Vide Potassae Antimonio-tartras.

Pulvis Antimo'nti Compositus.—Compound Powder of Antimony.

HISTORY.—Dr. James, who died in 1776, prepared a celebrated ant medecine, long known as the fever powder of Dr. James (pulvis ifugus Jacobi), or Dr. James's Powder (pulvis Jacobi). The discovery of it was subsequently claimed for a German of the name of Wanberg (Affidavits and Proceedings of W. Baker, Lond. 1754). The nomenclature which Dr. James lodged in the Court of Chancery is so ignobly worded, that we cannot prepare his powder by it. Hence
the present preparation has been introduced into the Pharmacopoeia as a successor for it. In preceding editions of the London Pharmacopoeia it was termed *pulvis antimonialis* (antimonial powder); but in the edition for 1836 this name was unnecessarily (as I conceive) altered to *pulvis antimonii compositus*. In the Edinburgh Pharmacopoeia it is denominated *oxydum antimonii cum calcis phosphate*; in the French Codex, *pulvis cum stibio compositus*.

**Preparation.**—In the London Pharmacopoeia it is directed to be prepared by throwing a mixture of one pound of sesquisulphuret of antimony in powder, and two pounds of hartshorn shavings, into a crucible red hot in the fire, and stirring constantly until vapour no longer arises. Rub that which remains to powder, and put it into a proper crucible. Then apply fire, and increase it gradually, that it may be red hot for two hours. Rub the residue to a very fine powder.

The process of the Dublin Pharmacopoeia is analogous to the above as are also those of the Edinburgh Pharmacopoeia and French Codex with the exception that in the two latter works equal parts of sesquisulphuret and hartshorn shavings are used.

Manufacturers usually substitute bone sawdust for hartshorn shavings.

The following is the *theory* of the process: the gelatinous matter of the horn (or bones) is decomposed and burned off, leaving behind the earthy matter (sub- or 3/2, phosphate of lime, with a little calcareous carbonate). The sulphur of the sesquisulphuret is expelled in the form of sulphurous acid, while the antimony attracts oxygen from the forming antimonious acid, and a variable quantity of sesquioxide of antimony. By the subsequent heating the sesquioxide is, for the most part converted into antimonious acid; but one portion is usually left unchanged, while another is volatilized. The carbonate of lime of the horn is decomposed by the united agencies of heat and antimonious acid: carbonic acid is expelled, and a small quantity of antimonite of lime formed. The side of the crucible in which the second stage of the process has been conducted, is found, at the end of the operation, to be lined with a yellow glaze, and frequently with yellow crystals of sesquioxide.

**Properties.**—Antimonial powder is white, gritty, tasteless, and odourless. Boiling water extracts the antimonite (and superphosphate, *D. Maclagan*) of lime: the liquid becomes cloudy on cooling. Hydrochloric acid, digested in the residue, dissolves the subphosphate of lime, all the sesquioxide of antimony, and a portion of the antimonious acid.

**Characteristics.**—The solution obtained by boiling antimonial powder in distilled water occasions white precipitates, soluble in nitric acid with oxalate of ammonia, nitrate of silver, and acetate of lead: hydro sulphuric acid gas transmitted through the solution, produces an orange precipitate. If the portions of antimonial powder not dissolved in distilled water be digested in boiling liquid hydrochloric acid, a solution is obtained, which, on the addition of distilled water, becomes turbid and deposits a white powder: at least I have found this to take place with several samples of antimonial powder which I have examined, and the same is noticed by Dr. Barker (*Observations on the Dublin Pharmacopoeia*, 204); but neither Mr. Phillips (*Ann. Phil. iv. N. S. 266*) nor I. Maclagan (*Edinburgh Med. & Surg. Journ.* No. 135) have observed Hydrosulphuric acid gas, transmitted through the hydrochloric solution
uses an orange red precipitate: if this be separated by filtering, and
the solution boiled to expel any traces of hydrosulphuric acid, a white
precipitate (phosphate of lime) is thrown down on the addition of caustic
ammonia. That portion of antimonial powder which is not dissolved by
hydrochloric acid is antimonial acid: if it be mixed with charcoal,
heated to redness, it is converted into sesquisoixide, or metallic
antimony.

Composition.—Dr. James’s Powder has been analysed by Dr. Pearson
Phil. Trans. Ixxxi. for 1791, p. 317); by Mr. Phillips (Ann. Phil. N. S.
187); by Berzelius (Traité de Chimie, iv. 481); by M. Pully (Ann. de
Min. 1805, lv. 74); by Dr. D. Maclagan (Edinb. Med. & Surg. Journ.
x. 462); and was imperfectly examined by Mr. Chenevix (Phil. Trans.
1801, p. 57). Antimonial powder has been analysed by Mr. Phillips
in. Phil. N. S. iv. 266), and by Dr. D. Maclagan (op. cit.) Their
results are, for the most part, shown in the following table:—

<table>
<thead>
<tr>
<th>JAMES’S POWDER.</th>
<th>ANTIMONIAL POWDER.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson</td>
</tr>
<tr>
<td>Lime (with</td>
<td>Newbury’s</td>
</tr>
<tr>
<td>superphosphate</td>
<td></td>
</tr>
<tr>
<td>Maclagan</td>
<td></td>
</tr>
<tr>
<td>Quioxide of Antimony Acid</td>
<td>57</td>
</tr>
<tr>
<td>Nitrate of Lime</td>
<td>43</td>
</tr>
<tr>
<td>Antimony, and impurity,</td>
<td>100</td>
</tr>
</tbody>
</table>

Pully found sulphate of potash and hypo-antimonite of potash in
James’s powder. Mr. Brande has found as much as 5 per cent. of ses-
quitoxide of antimony in the antimonial powder of the shops.
The antimonite of lime is obtained in solution by boiling antimonial
water in distilled water: the greater part of it deposits as the solution
settles. The existence of superphosphate was inferred by Dr. Maclagan,
in the precipitates produced with the salts of lead and nitrate of silver.

Phillips assumed the non-existence of sesquisoixide of antimony,
cause the hydrochloric solution did not let fall any precipitate on the
filtration of water: an assumption which is certainly not correct, since a
full quantity of sesquisoixide may be dissolved in this acid without our
being able to obtain any evidence of its presence by the action of water.
Maclagan (op. cit.) has shown, that if hydrosulphuric acid gas be
emitted through the solution, an orange red precipitate is obtained,
each he supposes to be an indication of the presence of sesquisoixide.
It unless the antimonial powder be boiled repeatedly in water, to
move completely the antimonite of lime, this test cannot be relied on:
if the least trace of this salt be present, an hydrated hydrochlorate
antimonial acid is obtained, which, it is well known, not only pro-
vides an orange red precipitate with hydrosulphuric acid, but even
uses a white precipitate on the addition of water (Gmelin, Handb. der
Chimie, ii. 986).

Physiological Effects.—Antimonial powder is most unequal in its
action,—at one time possessing considerable activity, at another being
 inert, or nearly so. This depends on the presence or absence of sesqui-
oxide of antimony, which may be regarded as constituting its active principle, and which, when present, is found in uncertain and inconstant quantity. Moreover, this variation in the composition of antimonial powder cannot be regarded as the fault of the manufacturer, since it depends, as Mr. Brande (Manual of Pharmacy, 3d. ed. p. 292) has justly observed, "upon slight modifications in the process, which can scarcely be controlled."

Mr. Hawkins gave 5j. morning and evening without any obvious effect; and the late Dr. Duncan, jun. administered 9j. and 5ss. doses several times a-day, without inducing vomiting or purging (Edinb. New Dispensat. 11th ed.) Dr. Elliotson (Cases illustrative of the Efficacy of the Hydrocyanic Acid, p. 77) found even 120 grains nearly inert; nausea alone being in some of the cases produced. In these instances I presume it contained little or no sesquioxide.

But, on the other hand, a considerable number of practitioners have found it to possess activity. Dr. Paris (Pharmacologia) observes, that "it will be difficult for the chemist to persuade the physician that he can never have derived any benefit from the exhibition of antimonial powder." I have above stated that the experiments on which Mr. Phillips founds his assertion that this preparation contains no sesquioxide are inconclusive, as Dr. Maclagan (op. cit.) has shown. I am acquainted with one case in which it acted with great activity. A workman employed in the manufacture of this powder in the laboratory of an operative chemist in London, took a dose of it (which, from his account, estimate at half a teaspoonful), and, to use his own words, "it nearly killed him." It occasioned violent vomiting, purging, and sweating.

Dr. James's powder, which some practitioners consider as more active and certain than our antimonial powder, appears to be equally inconstant in its operation. Dr. D. Monro (Treatise on Med. & Pharm. Chem. i. 367) who frequently used this powder, and saw Dr. James himself, as well as other practitioners, administer it, observes—"like other active preparations of antimony, it sometimes operates with great violence, even when given in small doses; at other times a large dose produces very little visible effects. I have seen three grains operate briskly, both upward and downwards; and I was once called to a patient, to whom Dr. James had himself given five grains of it, and it purged and vomited the lady for twenty-four hours, and in that time gave her between twenty and thirty stools; at other times I have seen a scruple produce little or no visible effect." Dr. Cheyne (Dubl. Hosp. Rep. i. 315) thought highly of it in the apoplectic diathesis: but he used it in conjunction with bleeding, purgatives, and a strict antiphlogistic regimen.

The preceding facts seem to me to show the propriety of omitting the use of both antimonial and James's powder, and substituting for them antimonial of known and uniform activity; as emetic tartar.

Uses.—Antimonial powder is employed as a sudorific in fevers and rheumatic affections. In the former it is given either alone or in combination with mercurials: in the latter it is frequently conjoined with opium as well as with calomel. In chronic skin diseases it is sometime exhibited with alteratives.

Administration.—The usual dose of it is from 3 or 4 to 8 or 10 grains in the form of powder or bolus.
Potassium Antimonio-Tartrate.—Antimony-Tartrate of Potash.

History.—This salt was first publicly noticed in 1631, by Adrian Mynsicht (Thesaurus Medico-Chymicus.) It has been known by various appellations, as tartarized antimony (antimonium tartarizatum), nitric tartar (tartarus emeticus), stibiated tartar (tartarus stibiatus), and tassio-tartrate of antimony (antimonii potassio-tartras, Ph. L.)

Preparation.—Antimony-tartrate of potash is prepared by boiling tartar of potash and sesquioxide of antimony (or some antimonial separation which contains it, as the oxychloride or an oxysulphuret) with water: the sesquioxide combines with the bitartrate to form antimony-tartrate of potash.

Antimony-ash (cinis antimonii), procured by roasting the sesquisulphuret, is employed to yield the sesquioxide in a manufactory in London. As already stated (p. 398), this compound is a mixture of sesquioxide, antimonious acid, and some undecomposed sesquisulphuret. The proportions of ash and bitartrate used vary according to the quality of the potash: the average being equal parts. This is the cheapest method of obtaining emetic tartar.

In the Dublin and United States Pharmacopoeias the oxychloride of antimony (oxydum antimonii nitro-muriaticum, Ph. Dub.), commonly called Algarth's powder, is employed. This is procured by pouring the sesquichloride (common butter of antimony, vide p. 399) into a large quantity of water, and washing the precipitate. In the preparation of the sesquichloride a small quantity of nitric acid should be employed to decompose the hydro-sulphuric acid remaining in the liquor, and which would impart the colour of the precipitate.

In the London Pharmacopoeia an oxysulphuret, very similar in composition to the old saffron of antimony (croceus antimonii) is used. It is thus prepared: two pounds of powdered sesquisulphuret of antimony are to be accurately mixed with the like quantity of powdered nitrate of potash: a sufficient quantity of hydrochloric acid are then to be added, and the powder, ignited, spread out on an iron plate. The residue is to be rubbed to a very fine powder, and, when cold, washed with boiling water until it is freed of taste.

It is then to be boiled for half an hour with fourteen ounces of bitartrate of potash in a gallon of distilled water. The liquor is to be strained while hot, and set aside to form crystals.

The theory of the process is this: part of the sulphur and of the antimony are oxidized at the expense of the oxygen of the acid of the nitrate, which sulphuric acid and sesquioxide of antimony are formed, while oxygen and binoxide of nitrogen escape. The sulphuric acid unites part of the potash of the nitrate. The hydrochloric acid reacts on the portion of potash, and produces water and chloride of potassium. If hydrochloric acid had been employed, the potash would react on the undecomposed sesquisulphuret, and generate antimonio-sesquisulphuret of potassium and sesquioxide of antimony. The residuum of the operation is, then, sulphate of potash, chloride of potassium, sesquioxide of antimony, and some undecomposed sesquisulphuret. By washing the sulphate and chloride are got rid of. The following diagram,
though imperfect, may perhaps assist the student in comprehending the foregoing changes:—

REAGENTS.

<table>
<thead>
<tr>
<th>Nitrate of Potash....</th>
<th>Potash....</th>
<th>Hydrochloric Acid ....</th>
<th>Sesquisulphuret Antimony</th>
<th>Sesquisulphuret of Antimony</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid.</td>
<td>Potash....</td>
<td>Hydrogen</td>
<td>Sesquisulphuret Antimony</td>
<td>Sesquisulphuret of Antimony</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potassium.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS.


The reacting equivalents have been omitted in the above diagram: but the results may be explained by assuming that 6 equivalents of nitrate, 7 equivalents of sesquisulphuret, and 1½ equivalents of hydrochloric acid, are employed. The products will be 6 eqs. of binoxide of nitrogen, 4½ eqs. of sulphate of potash, 1½ eqs. of water, 1⅔ eqs. of chloride of potassium, 3 eqs. sesquisoxide of antimony, and 4 eqs. sesquisulphuret.

The changes in the second stage of the process are readily comprehended: two equivalents or 154 parts of sesquisoxide of antimony combine with one equivalent or 180 parts of dry bitartrate of potash, to form one equivalent or 334 parts of dry emetic tartar, which, in crystallizing, unite with three equivalents, or 27 parts of water. The sesquisulphuret is macted on by the bitartrate of potash.

REAGENTS.

<table>
<thead>
<tr>
<th>3 eq. Water.</th>
<th>1 eq. dry Bitartrate.</th>
<th>1 eq. Tart. Acid.</th>
<th>Oxysulphuret.</th>
</tr>
</thead>
</table>

PRODUCTS.

<table>
<thead>
<tr>
<th>27</th>
<th>114</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. crystalline Antimony.</td>
<td>1 eq. Ditart. Antim.</td>
</tr>
</tbody>
</table>

Properties.—Emetic tartar crystallizes in white, transparent, inodorous, rhombic octahedrons, whose lateral planes are striated. By exposure to the air they become opaque, probably by giving out an equivalent of water. Their taste is feebly-sweetish, then styptic and metallic. They dissolve in 14 or 15 parts of water at 60° F. \((12\frac{6}{10}°\) at 70°, Brandes), and in 2 parts \((2\frac{7}{8}°\) parts, Brandes) at 212°. Their aqueous solution slightly reddens litmus and undergoes decomposition by keeping, like that of tartaric acid and most tartrates. Alcohol will not dissolve this salt. By calcining emetic tartar in close vessels we obtain a pyrophoric alloy of antimony and potassium. They decrystallize in the fire.

Characteristics.—Heated in a porcelain or glass capsule it chars, showing it contains an organic substance (tartaric acid). If the charred salt be heated in a glass tube by a blowpipe, globules of antimony are obtained.

If a stream of hydrosulphuric acid gas be transmitted through a watery solution of emetic tartar \((\text{vide} \text{fig. 65, p. 409})\), the latter becomes orange-red; if a small quantity of hydrochloric acid be then added, a flocculent orange-red precipitate (hydrated sesquisulphuret of antimony) takes place. This precipitate is to be collected and dried, and introduced into a green glass tube. Then transmit a current of hydrogen gas over it, and after a few minutes apply the heat of a spirit lamp to the sesquisulphuret: hydrosulphuric acid and sesquisulphuret of antimony are formed.
At present, the sesquisoxide of antimony thrown down by the alkalis is soluble in excess of the precipitant. The precipitate formed by sulphuric or nitric acid is the sesquisoxide combined with a small quantity of the acid. Nitric acid does not occasion any precipitate.

**Composition.**—The following is the composition of this salt:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony 2...</td>
<td>15...</td>
<td>42... 65...</td>
</tr>
<tr>
<td>Ash 1...</td>
<td>48... 13... 29...</td>
<td>13... 26...</td>
</tr>
<tr>
<td>Tartric Acid 2...</td>
<td>132... 36... 36...</td>
<td>38... 61...</td>
</tr>
<tr>
<td>Water 3...</td>
<td>27...</td>
<td>74... 7...</td>
</tr>
</tbody>
</table>

The sesquisoxide of antimony performs the function of the electro-negative or acid constituent, the tartrate of potash, the electro-positive or basic constituent.

**Purity.**—In the crystalline state the purity of this salt is easily determined. The crystals should be well formed, perfectly colourless, transparent, or opaque, and when dropped into a solution of hydrosulphuric acid have an orange-coloured deposit formed on them.

When pure the powder of this salt is perfectly white. Some ignorant sugar-pursue prefer a yellowish white powder, and I am informed by a manufacturer of this salt that he is obliged to keep two varieties (one...
white, the other yellowish white), to meet the demands of his customers! The yellow tint is owing to the presence of iron, which is readily detected in the salt by the blue colour immediately produced in its solution by adding first a few drops of dilute sulphuric acid, and then ferrocyanurate of potassium.

Emetic tartar is sometimes adulterated with bitartrate of potash. According to Mr. Hennell (Phillips's Transl. of the Pharm. 3d ed.) the antimonial salt may contain 10 per cent. of bitartrate, and yet the whole will dissolve in the proper quantity (14 or 15 parts) of water. In order to detect any uncombined bitartrate, he adds a few drops of a solution of carbonate of soda to a boiling solution of the antimonial salt, and if the precipitate formed be not dissolved, he concludes that there is no bitartrate of potash present.

A pure solution of emetic tartar should occasion no precipitate with chloride of barium: it produces a white precipitate (unless the solutions be very dilute) with nitrate of silver, soluble in excess of water.

**Physiological Effects.** (a.) On vegetables.—Emetic tartar acts as a poison to plants (vide the experiments of Schübler and Zeller, in Schweigiger's Journ. f. d. Chem. 1827, B. 50, S. 54-66.)

(b.) On animals.—An extended examination of the effects of emetic tartar on the different classes of animals is still a desideratum. Hitherto experiments with it have been principally confined to dogs, rabbits, horses, oxen, sheep, and cats. Moiroud (Pharm. Vétér. 287) has given two drachms to horses, and gradually increased the dose to six ounces, without perceiving any remarkable and permanent derangement in the exercise of the principal functions. Gilbert (quoted by Moiroud) has exhibited ten drachms to a cow and four to a sheep without any remarkable effect: but six drachms killed an animal of the latter species. Magendie (in Orfila's Toxicol. Gén.) examined its effects on dogs. He found that from six to ten grains introduced into the stomach killed the animals in from two to three hours, when the gullet was tied: those who were able to get rid of it by vomiting took as much as a drachm without experiencing any bad effects, and in some cases half an ounce caused no ill effects. From his experiments it appears to operate locally and by absorption, its principal action being on the intestinal canal and lungs: for nausea, vomiting, alvine evacuations, difficulty of respiration, and accelerated respiration, were produced by injecting a solution of the salt into the veins, by introducing it into the stomach, as well as by applying it in the solid state to the cellular tissue. Traces of pneumonia, gastritis, and enteritis, were found after death. These experiments have been repeated by Rayer and Bonnet (Dict. de Med. et de Chir. Prat. iii. 20) on rabbits; but without obtaining the lesion of the lungs mentioned by Magendie: in some cases no appreciable lesion was observed in any organ. Dr. Campbell (quoted by Dr. Christison) found no pulmonary inflammation in a cat killed by this salt. According to Flourens (Journ. de Chim. Méd. ix. 21) emetic tartar injected into the veins of ruminants causes efforts to vomit, but not actual vomiting; of the four stomachs possessed by these animals, the reed or true stomach is the only one affected by it.

(c.) On man. a. Local effects.—Emetic tartar is a powerful local irritant, but not a caustic; that is, it does not exercise any known chemical influence over the parts with which it is placed in contact. Its irritant
Properties may be regarded as of a peculiar or specific kind, at least if
are to judge from its well-known effects when applied to the epi-
mis. To observe these, we may sprinkle the powder over a plaster,
employ the salt in the form of solution or of ointment. By any of
these modes of application we obtain an eruption of painful pustules,
embling those of variola or ecthyma. The smaller ones are seniglo-
lar; the larger ones, when at their height, are flattened, are surrounded
th an inflammatory border, contain a pseudo-membranous deposit and
pe purulent serum, and have a central dark point. When they have
rained their greatest magnitude, the central brown spots become larger
darker, and, in a few days, desiccation takes place, and the crusts are
town off. The largest are produced by using the powder sprinkled
or a plaster; the smallest are developed by applying the solution.
are usually very painful. I am acquainted with no pharmacological
tent producing an eruption precisely similar. The facility with which
s eruption is produced varies considerably in different individuals, and
the same individual at different times.

In consequence of the internal use of it, a similar pustular eruption
been met with in the mouth, œsophagus, and small intestines, and
ite aphthous spots have been observed on the velum and tonsils
pelletier, De l'Emploi du Tart. Stibié, p. 171). But these effects
are rare.

We have further evidence of the local irritation produced by emetic
tar, in its action on the stomach and intestines. When swallowed in
doses it gives rise to vomiting and purging, pain in the epigastric
ion, and, after death, redness of the gastro-intestinal membrane has
en found. However, it would appear from the experiments of
lendie, before referred to, that part of this effect should be referred to
pecific influence which emetic tartar exerts over the stomach, inde-
dent of its direct local irritation, since the same symptoms have been
duced by the application of this substance to wounds, or by its injec-
into the veins.

Occasionally constitutional effects (nausea, vomiting, and griping pains)
re appeared to result from the application of emetic tartar to the skin
urn. de Chim. Méd. iv. 478). In one instance death resulted from its
ployment: the patient was an infant two years of age, and death
urred in forty-eight hours (Med. Repos. xvi. 357). These effects, if
ly produced by this salt, occur very rarely. I have applied to the skin
etic tartar (in the form of solution, ointment, and plaster) in more than
hundred cases, without having observed any constitutional effect;
ugh I have occasionally fancied that it ameliorated pulmonary aec-
us, even when no eruption or redness was produced, and which might
be from absorption.—(See some experiments on this subject in Mem. of
Med. Soc. of Lond. vols. ii. iv. and v.)

3. Remote or constitutional effects.—Taken internally, in small doses,
etic tartar increases secretion and exhalation of the gastro-enteritic
brane, and of the liver and pancreas. Subsequently it acts power-
y on other emunctories: thus it causes sweating, without any very
ked vascular excitement; it renders the mucous membranes (espe-
ly the aérian membrane) moister, and, when the skin is kept cool,
motes the secretion of urine. These effects are produced more eer-
ily and speedily by this salt than by any other antimonial preparation.
In somewhat larger doses it excites nausea, frequently with vomiting, disorders the digestive functions, gives rise to an uneasy sensation in the abdominal region, depresses the nervous functions, relaxes the tissues (especially the muscular fibres), and occasions a feeling of great feebleness and exhaustion. These symptoms are accompanied or followed by increased secretion and exhalation from the different eumctories, but especially from the skin, as above mentioned. Of all emetic substances this creates the most nausea and depression.

In excessive doses emetic tartar has, in a few instances, acted as an irritating poison, and even occasioned death. In one case a scruple, in another 27 grains, nearly proved fatal (Orfila, Toxicol. Général.) In a third 40 grains caused death (ibid.) The symptoms in the latter case were vomiting, hypercatharsis, convulsions, epigastric pain and tumefaction, and delirium. Death occurred four days after the ingestion of the poison.

Were the above cases not well authenticated, we should be disposed to ascribe the dangerous symptoms, and death, to some other circumstance than the use of the above-mentioned quantities of emetic tartar; for of late years this salt has been extensively employed in enormous and repeated doses with perfect safety. Rasori (Bayle’s Bibliothèque de Thérapie. t. 198) has given many drachms in twenty-four hours, and many ounces during the course of a disease, without occasioning either vomiting or abundant alvine evacuations. Laennec (Treatise on Diseases of the Chest, by Dr. Forbes, p. 249) has confirmed, to a certain extent, the statements of Rasori. He gave a scruple, two scruples, and even a drachm and a half within twenty-four hours (usually in doses of one, two, or three grains) without ever having seen any injurious consequences. The usual effects which I have observed from the continued use of one or two grain doses, are, nausea, vomiting, and purging, which in most cases are much diminished, or entirely cease, in a day or two. Perspiration I have found to be a frequent effect. In all the instances above referred to, in which these large doses were administered the patients were affected with inflammatory diseases. Now it is to this morbid state, or diathesis, that, according to Rasori (op. cit.) we ought to ascribe the tolerance of, or capability or aptitude of bearing, these immense quantities of so powerful a medicine (vide p. 33, for some remarks on the Italian theory of contra-stimulus). Consequently, if the opinion be worth anything, the susceptibility to the influence of the medicine should increase as the disease subsides; a circumstance which Rasori asserts really takes place. But in this the theoretical views of this distinguished Italian have probably led him to overlook the fact. "It is certainly true," observes Laennec (op. cit.), "that after the acute period of the disease [pneumonia], the tolerance diminishes, or sometimes entirely ceases; but it is more common to find the patient become habituated to the medicine, insomuch that during convalescence, and when he has begun to use food as in health, he will take daily, without knowing it, six, nine, twelve, or even eighteen grains of the emetic tartar." Though I have seen this salt extensively employed in both public and private practice, I have never met any satisfactory cases supporting Rasori’s assertion of the diminished tolerance when the patient becomes convalescent. Moreover, large doses have been taken by healthy individuals without any remarkable effects. Alibert (Now. Elém. d. Thérapie. 5th ed.)
259) saw, at the Hôpital St. Louis, a man who took a drachm of this salt, in order to poison himself, but suffered no remarkable inconvenience from it. Lebreton (Orfila's Toxicol. Gén.) reports the case of a girl who swallowed six drachms at once as a poison: oil was immediately given; vomiting took place, and she soon recovered. Other published cases might be brought forward in proof of the slight effects of large doses of this salt, but I must content myself with referring to the Memoir of Magendie (De l'influence de l'emetique) for notices of men. I may add, however, that this distinguished physiologist concludes, that the comparative slightness of the effects arose from the evacuation of the salt a few moments after its ingestion; but in several, at least, of the cases, this was not proved; and in one it certainly did not happen—it was that of a man who swallowed 27 grains of this salt, and did not vomit.

The action of large doses of emetic tartar on the circulation and respiration is usually that of a sedative. This has been very frequently, though not constantly observed. In one case of peripneumonia, the daily use of from six to eight grains of this salt reduced the pulse, in nine days, from 120 to 34 beats per minute, and diminished the number of inspirations from 50 to 18 (Bouneau et Constant, quoted by Lepelletier, De l'emploi du Tart. Stib. 84). In another the pulse descended, in three days, from 72 to 44 beats per minute (Trousseau, quoted by Lepelletier).

Modus Operandi.—Though emetic tartar has not hitherto been detected by its chemical characters in the solids or fluids of the body, yet analogy is much in favour of Magendie's statement, that it gets into the circulation, and in this way produces its constitutional effects. M. Barré, quoted by Rayer, Dict. de Méd. et de Chir. Prat. iii. 69) has endeavoured to prove the reverse of this; namely, that emetic tartar cannot be absorbed by the healthy mucous membrane of the alimentary canal; but, in my opinion, neither his experiments nor his inferences are worth much. A fact mentioned by Minaret (Lond. Med. Gaz. xiii. 496) strongly supports the common opinion of absorption. A young woman labouring under pleuritis took emetic tartar, which operated on the child at her breast as well as on herself.

Several parts of the body are influenced by this salt. The specific affection of the alimentary canal (especially of the stomach) is shown by the vomiting and sometimes purging produced, not only when the medicine is swallowed, but when it is injected into the veins or into the windpipe, or when applied to the serous coats of the intestines, or to the cellular tissue. If it purge or occasion sweating, it usually causes thirst, but not commonly otherwise. The appetite and digestion are frequently impaired. After the use of it for some days, patients sometimes complain of irritation in the mouth and throat, with a metallic taste: this has been considered a sign that the system is saturated with antimony, and that the use of it should be suspended. A pustular eruption was occasionally appeared in the mouth, as I have already mentioned (p. 411).

Magendie ascribes to emetic tartar a specific power of causing engorgement or inflammation of the lungs; for he found, on opening the bodies of animals killed by it, that the lungs were of an orange red or violet colour, incapable of crepitating, gorged with blood, and here and
there hepatic. Moreover, it has been assumed that the same effects are produced in the human pulmonary organs; and in support of this opinion a case noticed by Jules Cloquet (Orfila, Toxicol. Gén.) has been referred to: it is that of a man who died of apoplexy, but who, within five days of his death, had taken 40 grains of tartar emetic. “In the lungs were observed blackish spots, very irregular, which extended more or less deep into the parenchyma of this organ.” Furthermore, it is argued, unless we admit a specific influence of antimony over the lungs, we cannot well explain the beneficial effects of this remedy in peripneumonia. In opposition to this view, I would remark, that in cases of poisoning by this substance in the human subject, no mention is made of difficulty of breathing, cough, pain, or other symptom, which could lead to the suspicion that the lungs were suffering; and in the case of poisoning related by Recamier (Orfila, op. cit.) we are distinctly told that the thorax was sound. Besides, we should expect that if emetic tartar had a tendency to inflame the lungs, or at least to occasion pulmonary engorgement, that large doses of it would not be very beneficial in acute peripneumonia. It would even seem that this substance must have an influence over the human lungs of an opposite kind to that supposed by Magendie; for, as already related, it reduces the frequency of respiration in a considerable number of instances.

The sedative influence of emetic tartar over the circulatory system has been already noticed: it is, however, not always evident.

The great depression of the muscular power, the diminution of the frequency of the pulse and fainting, the epigastric pain sometimes experienced under circumstances that almost preclude the supposition of gastric inflammation, the cramps and convulsions, the delirium and insensibility, caused by emetic tartar in poisonous doses, are referrible to the influence of this substance over the nervous system.

The absorbent system is supposed to be stimulated to greater activity by emetic tartar, in consequence of the disappearance of serous and synovial effusions under its use. Moreover, Laennec (op. cit. p. 203) ascribed the efficacy of it in peripneumonia to the increased activity of the interstitial absorption.

The influence of it over the secreting organs has been before referred to. Every one is familiar with its diaphoretic properties. Its diuretic effect is best seen when the skin is kept cool, and when neither vomiting nor purging supervene. Magendie says, it augmented the secretion of saliva in dogs; and the same effect has been observed in man by Drs. Griffith and Jackson. The menstrual discharge is not checked by it; but occasionally has come on under its use.

Uses.—As an emetic, this salt is usually administered by the stomach, but it is sometimes used as an enema, and injected into the veins. When administered by the stomach, it is generally given in doses of one or two grains, frequently in combination with ten or fifteen grains of ipecacuanha. When our object is merely to evacuate the contents of the stomach, and with as little constitutional disorder as possible (as in cases of narcotic poisoning), other emetics (as the sulphates of zinc and copper) are to be preferred, since they occasion less nausea and depression of system, while they excite speedy vomiting. On the other hand, when we use vomiting as a means of making an impression on the system, and thereby of putting a sudden stop to the progress of a disease, emetic tartar is by far
in best vomit. It is with this view that it is sometimes employed in the early stages of fever, especially when accompanied by gastric or bilious disorder. It is most efficacious when given at the very commencement of the symptoms, and before the disease is fully formed. In such cases it occasionally puts an entire stop to the progress of fever. But, unfortunately, the practitioner is not usually called in to see the patient until the coper, period for the exhibition of an emetic has passed by,—that is, until the disease is fully established. Emetic tartar is used as a vomit with considerable success in the early stage of inflammatory diseases, especially in croup, tonsillitis, swelled testicle, bubo, and ophthalmia. Here also the success of the remedy is in proportion to its early application. In croup it should be given to excite in the first instance vomiting, and afterwards prolonged nausea. Under this plan of treatment I have seen two or three slight cases completely recover without the use of any other remedial agent. Dr. Copland (Dict. of Pract. Med. i. 467) also bears testimony to the success of the practice. In most cases it will be found advisable to precede the use of this medicine by blood-letting. Dr. Cheyne (Essay on Cynanche Trachealis, 1801) advises the employment of emetic tartar in the second stage of croup, for the purpose of moderating vascular action, and of promoting the separation of the adventitious membrane. But I am disposed to rely chiefly on calomel (given so as speedily occasion ptyalism) and blood-letting. Dr. Cheyne recommends half a grain of emetic tartar to be dissolved in a table-spoonful of water, and given to a child two or three years of age, every half hour till sickness and vomiting are produced; and in two hours after the last act of vomiting the same process is to be recommenced, and so repeated while the strength will admit. Another disease which is relieved by the occasional use of emetics is hooping-cough. They should be administered at the commencement of the disease, every, or every other day. They diminish the violence and length of the fits of spasmodic coughing, and promote expectation. Emetic tartar is particularly valuable in this disease in consequence of being tasteless, and, therefore, peculiarly adapted for exhibition to children. In derangements of the hepatic functions indicating the employment of emetics, this salt is usually preferred to other vomiting agents, on account of its supposed influence in promoting the secretion of bile.

Clysters containing emetic tartar have been employed to occasion vomiting, but they are very uncertain in their operation. Rayer has frequently employed from 6 to 12 grains without producing either nausea or vomiting. It has been repeatedly injected into the veins to excite vomiting. The usual dose is two or three grains dissolved in two ounces of water; but in some cases six grains have been employed. The effects are unequal: when vomiting does occur it is not always immediate; frequently it does not take place at all (Dieffenbach, Transf. d. Blut. u. d. Infus. d. Arzn. 15.) In several cases of choking from the lodgment of pieces of meat in the esophagus, this remedy has been applied with great success: vomiting was produced, and with it the expulsion of the meat. It has also been used in epilepsy and trismus: frequently with dangerous consequences (Dieffenbach, op. cit. 49.) Meckel employed it to restoreanimation in asphyxia by drowning (ibid).

As a nauseant, to reduce the force of the circulation and the muscular
power, emetic tartar is frequently of considerable service. Thus in dislocations of the larger joints (the hip and shoulder, for example), blood-letting, and nauseating doses of emetic tartar, are employed to diminish the resistance of the muscles opposing the reduction.

Emetic tartar, in large doses, is a most powerful and valuable remedy in the treatment of inflammation, especially peripneumonia. As an emetic, nauseant, or diaphoretic, it has long been in use in this disease; having been employed by Riverius in the 17th century, and subsequently by Stoll, Brendel, Schroeder, and Richter, in Germany; by Pringle, Cullen, and Marryat, in England. But as a remedy for inflammation, independent of its evacuant effects, we are indebted for it to Rasori (see the French translation of his Memoir, in Bayle's Biblioth. de Thérap. i. 198), who first used it in the years 1799 and 1800, in an epidemic fever which raged at Genoa. Subsequently he exhibited it much more extensively, and in larger doses, in peripneumonia. This mode of treatment was tried and adopted in France, first by Laennec (Treat. on Dis. of the Chest, translated by Dr. Forbes); in this country by Dr. Ballfour (Illust. of the Power of Emet. Tart. 2d edit. 1819). Its value as an antiphlogistic is now almost universally admitted. Practitioners, however, are not quite agreed as to the best method of using it. Rasori (op. cit.), Laennec (op. cit.), Recamier (Gaz. Méd. 1832, p. 503), Broussais (Cours de Path. et de Thérap. gén. ii. 521), Bouillaud (Dict. de Méd. et de Chir. praticq. xiii. 395), Dr. Mackintosh (Pract. of Phys. i. 426), Drs. Graves and Stokes (Dubl. Hosp. Rep. v. p. 48), Dr. Davis (Lect. on Dis. of the Lungs and Heart, 188), and most practitioners of this country, employ blood-letting in peripneumonia, in conjunction with the use of emetic tartar. But by several continental physicians the abstraction of blood is considered both unnecessary and hurtful. Thus Peschier (Bayle, Bibl. Thér. i. 246) advises us on no account to draw blood: and Trousseau (Dict. de Méd. 2d edit. iii. 220) observes, that blood-letting, far from aiding the action of emetic tartar, as Rasori, Laennec, and most practitioners, imagine, is, on the contrary, singularly injurious to the antiphlogistic influence of this medicine. On these statements I would observe, that few practitioners in this country have ventured to trust to emetic tartar alone in the treatment of violent pulmonary inflammation. Of its efficacy when used alone, in several slight cases of pneumonia, I can bear testimony; but in severe cases I have invariably conjoined blood-letting, and I believe most British practitioners have done the same. Louis (Rech. de la Suignée) has published some numerical results of the treatment of inflammation of the lungs by blood-letting and by emetic tartar; from which it appears that this substance, given in large doses, where blood-letting appeared to have no effect, had a favourable action, and appeared to diminish the mortality (op. cit. p. 62). But he particularly states that blood-letting must not be omitted (p. 32).

Laennec's mode of using this salt, and which, with some slight modification, I believe to be the best, is the following:—Immediately after bleeding give one grain of emetic tartar, dissolved in two ounces and a half of some mild fluid [cold weak infusion of orange flowers], sweetened with half an ounce of syrup of marshmallows: this is to be repeated every two hours for six times, and then suspended for seven or eight hours, if the symptoms are not urgent, or if there be any inclination to sleep. But if the disease has already made progress, or if the oppression
great, or the head affected, continue the medicine until amendment place; and in severe cases increase the dose to two, or two and a half grains. The only modification in this plan, which I would venture to oppose, is, to begin with a somewhat smaller dose (say one-third or one-half of a grain), and gradually increase it; for in consequence of the violent vomiting which one grain has sometimes produced, I have found patients positively refuse to continue the use of the medicine.

From my own experience I should say, that emetic tartar is nearly as viceable when it causes moderate sickness and slight purging, as when occasions no evacuation: but many practitioners deny this. Laennec observes, that "in general the effect of emetic tartar is never more rapid, more efficient, than when it gives rise to no evacuation; sometimes, however, its salutary operation is accompanied by a general perspiration. Though copious vomiting and purging are by no means desirable, on account of the debility and hurtful irritation of the intestinal canal which may occasion, I have obtained remarkable cures in cases in which evacuations had been very copious" (op. cit. p. 251). A few drops tincture of opium may be sometimes conjoined with the antimony, to check its action on the alimentary canal.

The attempts which have been made to explain the modus medendi of emetic tartar in pneumonia and other inflammatory diseases, are most satisfactory. Whilst almost every writer, even Bouillaud, admits its efficacy in inflammation, scarcely two agree in the view taken of the mode by which the good effects of this remedy are produced; as the following statement proves. Rasori explains its operation according to the principles of the theory of contra-stimulus (vide p. 33), of which he may regarded as the founder. He considers emetic tartar endowed with power of directly diminishing the inflammatory stimulus; of destroying the diathesis, and of being, therefore, a real contra-stimulus. Broussais, Bouillaud, and Barbier, ascribe its curative powers to its revulsive or irritative action on the gastro-intestinal membrane. Laennec thinks that it acts by increasing the activity of interstitial absorption. Fontelles supposes that the antiphlogistic effect depends on alterations the composition of the blood. Eberle (Mat. Méd. i. 66) refers it to sedative effects, first, on the nervous system, and consecutively on the art and arteries. Teallier thinks that, like many other therapeutic agents, it influences the organism by concealed curative properties. Macartney (A Treatise on Inflammation, 1838) regards it as a medicine diminishing the force of the circulation, by the manner which it occasions. These examples are sufficient to show the unsatisfactory condition of our present knowledge as to the mode by which emetic tartar exudes its curative effects. But this is no argument against the existence of remedial powers. Shall we deny the efficacy of blood-letting in inflammation, of mercury in syphilis, of cinchona in intermittents, of emetic in lepra, of sulphur in scabies, of hydrocyanic acid in gout? of a host of other remedies, simply because we cannot account for their beneficial effects? "The fact is, that in the present state of our knowledge we cannot explain the modus medendi of a large number of the best and most certain remedial means.

In pleurisy emetic tartar does not succeed so well as in inflammation of substance of the lungs. "It, indeed, reduces speedily the inflammatory action," says Laennec (op. cit. p. 250); "but when the fever and pain
have ceased, the effusion does not always disappear more rapidly under the use of tartar emetic than without it.” I have sometimes conjoined opium (always after copious blood-letting) with advantage. In bronchitis (both acute and chronic) it may be most usefully employed, in conjunction with the usual antiphlogistic agents (vide also Dr. Kemp, Lond. Med. Gaz. xix. 300, and Mr. Ellis, op. cit. p. 369). In rheumatism (especially the kind called arthritic), next to peripneumonia, emetic tartar has been found by some practitioners (especially by Laennec, op. cit.) more efficacious than in any other inflammatory affection: the usual duration of the complaint, when treated by this remedy, was found by Laennec to be only seven or eight days (see also Bayle's Bibl. Thérap. i. 311, and Lepelletier, De l'Emploi du Tart. Stib. p. 220). In muscular rheumatism it succeeds less perfectly. Synovial effusions (whether rheumatic or otherwise) have, in some cases, given way rapidly to the use of emetic tartar (Laennec, op. cit. p. 263, and Gimelle, Brit. & For. Med. Rev. for July 1838, p. 224). My own experience of the use of this medicine in rheumatism is not so favourable to its employment as the above reports would lead us to expect. In arachnitis, Laennec has seen all the symptoms disappear, under the use of emetic tartar, in 48 hours. In three instances of acute hydrocephalus, all the symptoms disappeared in the same space of time. In phlebitis (Laennec, op. cit.); in inflammation of the mamme occurring after delivery (Dr. E. Kennedy, Mr. Lever, and Dr. Ashwell Lond. Med. Gaz. xx. 761); in ophthalmia, and various other inflammatory affections, emetic tartar has been successfully employed as an antiphlogistic.

In continued fever emetic tartar is of considerable service. Mild cases are benefited by the use of small doses (as from one-sixteenth to one-fourth of a grain), as a diaphoretic. In the more severe form of the disease, accompanied with much vascular excitement, emetic tartar, in the dose of half a grain or a grain, may be usefully administered as an antiphlogistic; but its use should, in general, be preceded by blood-letting. In the advanced stages of typhus fever, accompanied with intense cerebral excitement, manifested by loss of sleep, delirium, &c. Dr. Graves (Lond. Med. Gaz. xx. 538) has obtained most beneficial results from the use of emetic tartar and opium. The same combination has been employed with great success in delirium tremens, as well as in delirium of erysipelas, scarlatina, and measles, by Dr. Law (Lond. Med. Gaz. xviii. 538 & 694).

Emetic tartar is one of our most valuable sudorifics, being oftentimes available when other agents of this class are inadmissible: for example, in fevers and other diseases, where we are desirous of producing diaphoresis, but which are accompanied with preternatural vascular action about the head, the use of those sudorifics (the compound ipecacuanha powder, for example) which contain a narcotic substance, is objectionable; whereas emetic tartar may be employed with safety, since it has no tendency to increase disorder of the nervous system, but to reduce cerebral excitement. On the other hand, when much gastric or enteric irritation is present, the narcotic sudorifics are generally to be preferred to antimony.

As an expectorant, in various pulmonary affections, small doses of this salt are frequently employed with advantage.

In some spasmotic complaints, the use of it has been followed, in th
instances in which it has been tried, with good effects (vide Laennec, cit. p. 260; Jacobi, Lond. Med. Gaz. iii. 784; and Mr. Ackerley, id. Med. Gaz. xxx. 56). In apoplexy it has been employed to depress crural vascular action, but its tendency to occasion vomiting renders it unourable.

As a local irritant, applied to the skin, it may be employed in the form of aqueous solution, ointment, or plaster. It is used in the same cases of vesiculatation, over which it has the advantage of not affecting the uo-genital organs. When it is desirable to keep up long-continued irritation, blisters are in some cases preferable. In chronic diseases of the chest it is used with the greatest advantage. I have found it much more effective than blisters, or any other kind of counter-irritant. I sometimes order one part of the chest to be rubbed until the eruption is probed; and then, after the interval of a day or two, apply it to another part, thus keeping up irritation by a succession of applications to different parts of the chest for several months. In this way it is most serviceable in chronic catarrhs, peripneumonies, and pleurisies. Even in faring phthisis I have seen the cough and pain alleviated by the application of antimonial friction. In hooping-cough it is also serviceable. Autenrieth recommended it as a means of diminishing the frequency of the paroxysms and the violence of the cough. In laryngitis occasionally of great service: as also in various affections of the joints, chiefly chronic inflammation of the capsular ligament, or of the synovial membrane, hydrops articular, particularly when connected with ulceration, and tumors of various kinds about the joints. In tic souræux (Hausbrandt, Brit. & For. Med. Rev. Jan. 1837, 230) it has been employed with benefit.

stimulating wash, composed of one scruple of tartar emetic to an ounce of water, was proposed by the late Sir William Blizard, in the 1787, to cleanse foul ulcers, repress fungous growths and venereal affections, and as an application to tinea capitis. A weak solution (as half an ounce to the ounce of water) has been employed as a stimulant in chronic melancholia, and in spots on the cornea.

Administration.—The dose of emetic tartar, in substance, is, as a diaphoretic and expectorant, 1/8 to 3/4 of a grain; as a nauseant, from 1/4 to 1 grain; as an emetic, from 1 to 2 grains; as an antiphlogistic, from 1/4 grain to 3 or 4 grains. This salt, however, rarely employed in medicine. Sometimes a grain of it, mixed with ten or fifteen grains of powdered ipecacuanha, is employed as an emetic. A mixture of one with sixteen grains of sulphate of potash may be employed, in doses from two to four grains, as a substitute for antimonial powder, to produce diaphoresis.

solution, it is commonly employed, as an expectorant, diaphoretic, ant, or emetic, in the form of antimonial wine. When used as an antiphlogistic, an aqueous solution of greater strength may be administered: it should be made with boiling distilled water in a glass vessel (Florence flask.)

For external use, emetic tartar is employed in the form of liniment, ointment, or plaster. A saturated solution is a very useful liniment: it is red by pouring an ounce and a half of boiling water over a drachm of tartar, and allowing the solution to stand till cold. In many cases it will be found preferable to the ointment; being the mildest, least...
painful, and cleanest. Another mode of employing emetic tartar externally is by sprinkling from ten to thirty grains of the salt in fine powder over Burgundy pitch plaster.

1. *Vinum Antimonii Potassio-Tartratis*, Ph. L.; *Vinum Antimonii*, Ph. U. S. (Emetic tartar, 3ij.; Sherry wine, f3xx.) *Liquor Tartinii Emetici* (emetic tartar, 3ij.; hot distilled water, f3yij.; rectified spirit, f3ij.) The Edinburgh formula is essentially the same as that of London. In all these formulæ the solution contains two grains of emetic tartar to one fluidounce of the liquid. It is important that Sherry, an inferior kind of wine, be employed: for the latter frequently contains matters which precipitate the sesquioxide of antimony. If the wine be good, and the salt pure, no precipitate is formed in the solution unless it be kept for a long period, when decomposition of the salt ensues. The Dublin formula is objectionable on account of its want of colour.

Antimonial wine is used, as a diaphoretic or expectorant, in doses from ten to thirty drops frequently repeated; as a nauseant, from one to two fluidraehms; as an emetic, about half a fluidounce, or two fluidraehms given at intervals of about ten minutes for four or five times, until the desired effect is produced; as an emetic for children, from three drops to a fluidraehm; as an antiphlogistic in peripneumonia, from two or three fluidraehms to an ounce; but for this purpose an extemporaneous but carefully made aqueous solution is to be preferred.

2. *Unguentum Antimonii Potassio-Tartratis*, Ph. L. (Emetic tartar, in fine powder, 3j.; lard, 3iv. M.) *Unguentum Tartari Emetici*, Ph. Dub. (Half the strength of the London formula.) In the preparation of this ointment it is important that the emetic tartar be in the state of very fine powder, in order to avoid the irritation produced by rough gritty particles on the skin. A portion of ointment about the size of a small nut is to be rubbed on the skin night and morning. After the use of it for two or three times, the painful condition of the part thereby induced commonly prevents further employment of friction. It is sometimes applied, spread on linen, without rubbing. By either of these methods a crop of painful pustules is produced: but the facility and rapidity with which they are developed varies considerably in different individuals. Occasionally adventitious eruptions have appeared in other parts of the body, which have been ascribed to absorption of antimony into the system (Gaz. Méd. 1832, p. 842.) But I believe with Ray (Treat. on Diseases of the Skin, by Dr. Willis, p. 540), that they are from the inadvertent application of the ointment to these parts. The ointment is used as a counter-irritant in various chronic maladies: thus it is applied to the chest in pulmonary affections, and to the joints in chronic diseases (whether rheumatic or otherwise). It should only be applied to sound portions of skin, and, therefore, leech bites, the searifications from cupping, wounds, &c. are to be carefully avoided: for severe inflammation and even gangrenous ulceration may be produced by not attending to this caution. I have before mentioned (p. 411) that in a very few cases severe and even fatal constitutional disorders have appeared to have resulted from the use of antimonial ointment.

**Antidote.**—Promote vomiting by tepid bland liquids. The antidote is said to be tannic acid, and vegetable substances which contain it yellow bark, tea, nutgalls, &c.) Faure (Lond. Med. Gaz. xvi. 703) commends the decoction in preference to other preparations of yel
But though cinchona decomposes emetic tartar it does not destroy activity. Some years since, at the General Dispensary, I saw from
2 grains of this salt, mixed with either powder or decoction of yellow
bark, given by Dr. Clutterbuck to nearly 100 patients: and in almost
every instance nausea and vomiting occurred. The experience of Laen-
(Diseases of the Chest, Forbes’s Translation, 257), as well as of
Ver (Dict. de Méd. et Chir. Prat. iii. 57), is to the same effect. Opium
is most valuable agent for checking excessive evacuations. Venese-
crits and the warm bath are also important means of relieving the gastro-
critis.

Order 18. Gold and its Compounds.

Au’rum.—Gold.

History.—Gold has been known from the most remote periods of anti-
quity. It was in common use 3,300 years since (Exodus, xi. 2), and was
tably the first metal with which mankind was acquainted. The
alchemists termed it Sol or Rex metallorum.

Natural History.—It is found only in the metallic state; commonly
ixed with other metals, especially with silver, tellurium, copper, and
. It occurs in veins in primitive rocks; and is also found in alluvial
osits in small lumps or particles called gold dust. It is found in sev-
parts of Europe, Asia, and Africa, but principally in America, espe-
cially the southern part.

Preparation.—The mode of extracting gold varies in different places,
ically according to the nature of the gangue. The ore is freed as
uch as possible from foreign matters, by mechanical processes (stamp-
washing, &c.) and sometimes by roasting; and is then smelted
some flux, as borax, to separate the stony matters. Or it is fused
lead, and afterwards submitted to cupellation: or amalgamated with
cury, and, after straining, distilled.

The separation of gold from silver (parting) may be effected in the
way by fusion, either with sulphur, by which metallic gold and sul-
ret of silver are procured, or with sesquisulphuret of antimony, by
ich sulphuret of silver and an alloy of gold and antimony are procured:
last mentioned metal may be separated by heating the alloy in the
as well as by other methods. Gold may also be freed from silver in
wet way by the process of quartation: that is, by treating an alloy of
parts of silver and one of gold with nitric acid, which dissolves the
other.

Properties.—The crystalline forms of native gold are the cube, the
cular octahedron, and their modifications. Pure gold has a rich yellow
our, a sp. gr. of 19'2 to 19'4, is soft, very ductile, and malleable, fuses
a bright red heat (2016° F. according to Daniell) and in the liquid
has a brilliant greenish colour. Its equivalent is somewhat under-
: Gmelin fixes on 66,—Thompson, 100,—Berzelius, 99'6,—Turner,
2,—and Brande, 200 : I shall adopt the last.

Characteristics.—Gold is readily distinguished by its colour and
ess, by its being unacted on by nitric acid, and by its ready solubi-
in nitro-hydrochloric acid. The solution is yellow, stains organic
ners (as the skin) purple, throws down, by the addition of protosulphate
of iron, metallic gold in the finely divided state, by protochloride of tin or borax, which has been touched with it acquires a pink or rose colour when fused with the blowpipe.

**Physiological Effects.**—Gold, like other metals, has been frequently supposed to be inert while it retains its metallic condition, but in this respect as well as in some other instances the accuracy of the assumption has been denied. Both Chrestien (Sur un Nouv. Remède dans le Traité. des Maladies Vén. Paris, 1811) and Niel (Rech. et Observ. sur les Effets des Prép. d'Or. Paris, 1821), as well as other writers, assert that finely divided metallic gold (pulvis aurī) produces the same constitutional effects as those caused by the various preparations of this metal, but in a milder degree, while it excites little or no local irritation. It is said to promote the secretion of the skin, kidneys, and salivary glands.

**Uses.**—It has been employed as an antivenereal and antiscrofulous remedy by Chrestien, Niel, and others, with considerable success. It is said to be preferable to the other preparations of this metal in delicate and nervous subjects, females, and infants. Gold leaf (aurum foliatum se lamellatum) is used by dentists for filling decayed teeth, and formerly by apothecaries for covering pills (ad inaurandas seu obducendas pilulas).

**Administration.**—It has been administered internally in doses from a quarter of a grain to a grain three or four times a day. Chrestien used it by way of friction on the tongue and gums. Niel employed it endermically (that is, applied it to the skin deprived of the epidermis) in the form of ointment composed of one grain of gold and thirty grains of lard.

**Pulvis Aurī** (Fr. Cod.) is prepared by rubbing leaf gold (aurum in laminas exilissimas complanatum) with sulphate of potash, sifting and washing with boiling water to remove the sulphate: or by adding protosulphate of iron to chloride of gold, and washing the precipitate, first with water, then with dilute nitric acid.

*Aurī Terchloridorum.*—Terchloride of Gold.

**Preparation.**—In the French Codex this is ordered to be prepared by dissolving, with the aid of heat, one part of gold in three parts of nitric acid. The solution is to be evaporated until vapours of chlorine begin to be disengaged, and then allowed to crystallize.

**Properties and Composition.**—Chloride of gold is in the form of small crystalline needles, of an orange-red colour, inodorous, and having a strong, styptic, disagreeable taste. It is deliquescent, on which account it should be preserved in a well-stoppered bottle: it is soluble in water, alcohol, and ether. When heated it evolves chlorine, and is converted, first into protochloride, and then into metallic gold, which is left in the spongy state. It reddens litmus, stains the cuticle purple, reduced by many metals (as iron, copper, tin, zinc, &c.), by several of the non-metallic elementary substances (as phosphorus), by some metallic salts (as protosulphate of iron), and by many organic bodies (as charcoal, sugar, gum, gallic acid, extractive, &c.), all of which, therefore, are incompatible with it. Nitrate of silver occasions a precipitate of chlorine of silver and oxide of gold: hydrochloric acid removes the latter.—(For other characteristics, vide p. 422). Terchloride of gold consists of 1 c. of gold = 200 + 3 eqs. chlorine, 108. The before-mentioned crystals are
Physiological Effects. (a) On animals.—Orfila (Toxicol. Gén.) examined the effects of the chloride of gold on animals, and infers from experiments, that when introduced into the stomach it acts as a cor-}

ivine, but with less energy than the bichloride of mercury, and destroys mals by the inflammation of the coats of the alimentary canal which sets up.

(b) On man.—On man its effects are analogous to those of bichloride mercury. In small doses it acts, according to Dr. Chrestien, more ergetically as a stimulant, though less powerfully as a sialogogue, than corrosive sublimate. It promotes the secretions of the skin, the salivary ends, and the kidneys. Taken to the extent of one-tenth of a grain it has occasioned violent fever. "This excitation," says Chrestien, regard as indispensably necessary for the cure of the diseases against which I administer gold: restrained within proper limits, it is never companied with any remarkable or even sensible lesion of the func-

ts. The mouth is good, the tongue moist, the appetite continues, the welns are not disordered, and there is ordinarily only augmentation of ure and transpiration: but if carried too far, we incur the risk of pro-
ging general erethism, inflammation of this or that organ, according to the predisposition of the patient, which will not only check the treat-
ment, but may even induce a new disease, often more troublesome than original one. The suspension or modification of the remedy should be governed by the unusual and sustained heat of skin." Cullerier, the ohew (Magendie, Formulaire, 8ème ed. p. 365), has seen one-fifteenth a grain excite, at the second dose, gastric irritation, dryness of the sialogue, redness of the throat, colic, and diarrhea. When it promotes the secretion of saliva it does not, as mercury, affect the teeth and gums rötzer, Rust's Magaz. B. 21, quoted by Wibmer). Magendie (op. j) has seen violent gastritis, accompanied by nervous symptoms (cramps all pains in the limbs, agitation, and loss of sleep), and afterwards great at of skin, obstinate sleeplessness, and fatiguing erections. In large ses it would probably occasion symptoms analogous to those produced the use of poisonous doses of bichloride of mercury.

Uses.—It has been employed, with variable success, as a substitute mercury in the treatment of the secondary symptoms of syphilis. A re extended experience of it is, however, necessary to enable us to speak of its remedial powers with confidence. In the hands of Christien cit.), Niel (op. cit.), Cullerier (Dict. des Sciences Méd. xxxvii. art. 1), Legrand (De l'Or, de son emploi dans la Traitement de la Syphilis, ris, 1832), and others, it has proved most successful.

It has also been used in scrofulous affections, bronchocele, chronic diseasues, scirrhous tumors, &c. Duportal (Ann. de Chimie, lxxviii. cured a case of obstinate ulceration of the face, regarded by him as vurious, and which had resisted all the ordinary methods of cure.

Legrand (Lond. Med. Gaz. xx. 414) has used chloride of gold, acidified th nitric acid, as a caustic, in syphilitic, scrofulous, and scorbutic cases, cancerous growths, and ulcerations of the neck of the uterus.

Administration.—Internally it has been given in doses of one-

ninth of a grain, made into pills with starch. But as organic matters
decompose it, it is better to use it in solution in distilled water, or apply it by friction to the mouth, in quantities of one-sixteenth to one-sixth of a grain.

Antidote.—The same as for poisoning by bichloride of mercury.

So'dii Au'ro-Terchlo'ridum.—Au'ro-Terchlo'ride of So'dium.

In the French Codex this is ordered to be prepared by dissolving 85 parts by weight of terchloride of gold, and 16 parts of chloride of sodium, in a small quantity of distilled water: the solution is to be evaporated by a gentle heat until a pellicle forms, and then put aside to crystallize.

The auro-terchloride of sodium crystallizes in orange-coloured quadrangular, elongated prisms, which are permanent in the air; but when they contain any uncombined terchloride of gold, they are slightly deliquescent. They are soluble in water. When heated, chlorine is evolved, and a mixture of gold and chloride of sodium is left behind. They consist of 1 eq. terchloride of gold = 308; 1 eq. of chloride of sodium = 60, and 4 eqs. of water = 36.

Its effects and uses are analogous to the terchloride of gold, over which it has the advantages of being more constant and less costly; in consequence of which it is the most used of the auric preparations. It is exhibited internally in doses of one-twentieth to one-tenth of a grain, made into pills with starch or lycopodium. Mixed with twice its weight of orris powder or lycopodium, it may be used in frictions on the tongue and gum. An ointment (composed of one grain to thirty-six grains of lard) may be applied, endemically, to the skin, deprived of its epidermis by a blister.

Au'ri Terox'y'dum.—Terox'ide of Gold.

This substance, sometimes called peroxide of gold or auric acid, is ordered, in the French Codex, to be prepared by boiling 4 parts calcined magnesia with 1 part terchloride of gold and 40 parts of water. Then wash, first with water, to remove the chloride of magnesium, afterwards with dilute nitric acid, to dissolve the excess of magnesia.

Teroxide of gold is brown; in the state of hydrate reddish yellow. It is reduced by heat and solar light. It is insoluble in water, but is soluble in hydrochloric acid (forming terchloride of gold), and in alkalies (forming aurates). It consists of 3 eqs. oxygen, 24 + 1 eq. gold = 200.

It is used internally, in venereal and scrofulous diseases, in doses of from one-tenth of a grain to a grain, made into the form of pills with extract of mezereon.

Aurate of Ammonia. Ammoniuret of teroxide of gold: fulminating gold.—This is prepared by adding ammonia to a solution of chlorid of gold. It is a yellowish brown powder, which explodes when heated to 400°. It has been employed in the same cases as the preceding compounds, as well as in fevers, nervous affections, &c. In some cases it has produced very serious and even fatal results (Plenck, Toxicologica, ed 2nd. 230).

Purpura Mineralis Cassii. Purple of Cassius: Aurum Stann'paratum, Fr. Cod.—The nature of this compound is so imperfectly
own, that it is impossible at present to assign to it its proper chemical
name. Its active principle is probably oxide of gold. There are several
methods of preparing it: the simplest is to add a solution of protochloride
of tin to a solution of chloride of gold, until a precipitate is no
longer produced. Filter and dry the precipitate.

The purple of Cassius is soluble in ammonia, and does not form an
algin with mercury: hence it does not appear to contain any metallic
silver. Its composition varies according to the mode of procuring it. Gold,
mercury, and tin, are its essential constituents.

This preparation is used in the same cases as the other preparations
gold.

_Au’ri Io’didum.—Io’dide of Gold._

This is ordered to be prepared, in the French Codex, by adding a solu-
tion of iodide of potassium to a solution of chloride of gold. Double
composition takes place, and iodide of gold falls down. This is to be
filtered on a filter, and washed with alcohol, to remove the excess of
iodine which precipitates with it.

Iodide of gold is of a greenish yellow colour, insoluble in cold water,
but slightly soluble in boiling water. Heated in a crucible it evolves
vapour, and is converted into metallic gold. It is probably com-
posed of 1 eq. iodine = 126, and 1 eq. gold = 200.

It has been employed internally, in venereal affections, in doses of from
one-fifteenth to one-tenth of a grain. Externally it has been applied in
form of ointment to venereal ulcers (Pierquin, _Journ. de Progrès._)

_Au’ri Tercyan’idum.—Tercy’anide of Gold._

The directions for preparing this salt, in the French Codex, are some-
what diffuse. The process consists essentially in very carefully adding
solution of pure cyanide of potassium to a solution of chloride of gold,
until a precipitate (cyanide of gold) ceases to be formed. The chloride
of gold, prior to solution, should be deprived of all excess of acid by
heating it in a salt-water bath.

Cyanide of gold is a yellow powder, which is insoluble in water. It
must, probably, of 3 eqs. cyanogen = 78, and 1 eq. gold 200. It has
been used in venereal and scrofulous affections, both externally and
internally. The dose is from one-fifteenth to one-tenth of a grain, made
to a pill, with some inert powder.


_Ar gen’tum.—Silver._

_History._—Silver, like gold, has been known from the most remote
periods of antiquity, being mentioned in the earliest books of the Old
Testament (Genesis, xlv. 2; Job, xxii. 25). It was termed by the alch-
ysts and astrologers, _Diana_ or _Luna._

_Natural History._—It is found in the mineral kingdom in various
forms; sometimes nearly pure; or alloyed with other metals (especially
gold, antimony, tellurium, arsenic, and copper); or combined with sulphur, selenium, iodine, or chlorine; or united to oxygen and carbo- 

cid. Of these, native silver and the sulphuret are by far the most ab-

dant.

Preparation.—The processes followed for the extraction of silver vary in different places, according to the nature of the ore: they are principally amalgamation and cupellation. At Freyberg the ore is mixed with common salt, and roasted, by which the sulphuret of silver is con-

verted into the chloride of this metal: water and iron are then added, to remove the chlorine, and the disengaged silver is finally dissolved in mercury (amalgamation), and the solution submitted to distillation, by which the mercury is volatilized, and the silver left behind (J. H. Vivian, in Taylor's Records of Mining, p. 21). The process of amalga-

mation followed in America is somewhat different (Boussingault, Ann. de 

Chim. li. 337; also Ward, Mexico in 1827, vol. ii. 437).

Silver is obtained from argentiferous galena, as follows:—The ore is first roasted to expel the sulphur, and afterwards smelted with charcoal. The argentiferous lead is then submitted to cupellation, by which the lead, becoming oxidized, is partly volatilized, and partly sinks into the cupel 

(cineritium), leaving the silver. (On the smelting processes of Hungary Saxony, &c., consult Taylor's Records of Mining, p. 51).

Pure silver is obtained by immersing a copper rod in a solution of the nitrate. The precipitate is to be digested in caustic ammonia, to remove all traces of copper, and afterwards washed with water.

Properties.—In the native state, silver occurs crystallized in the cube and regular octahedron. When pure this metal is white, with a slight shade of yellow; inodorous and tasteless. It is moderately hard and 

elastic; very ductile and malleable: a single grain may be drawn out into 400 feet of wire, and leaf silver (argentum in laminas extensum; argentum foliatum) may be procured, whose thickness is only \frac{1}{1000} \text{ of an inch. Its sp. gr. is 10'474. It melts at a bright red heat (1873° F} according to Daniell). When exposed to the air it does not oxidate, but readily tarnishes by sulphureous vapours. Its equivalent is 108.

Characteristics.—It is soluble in nitric acid: the solution thus obtained throws down a white precipitate—[see the properties of this chloride, p. 105]—with hydrochloric acid or the chlorides; with the alkaline carbonates, oxalates, and ferrocyanides; yellow with the phosphates and arsenites; red with the arseniates; olive-brown with the alkalies or lime water; metallic silver with phosphorus or copper; black with hydrosulphuric acid.

Purity.—The silver of the shops usually contains traces of gold and copper.

Physiological Effects.—Silver in the metallic state is totally inert.

Uses.—In pharmacy it is used for the preparation of the nitrate which is employed as a medicine and as a test.

Silver leaf is used for filling the hollows of decayed teeth, and was formerly employed to cover pills. An amalgam of silver is also used by some dentists for stopping teeth. It is objectionable on account of its 

blackening them.
**Argenti Nitrates. — Nitrate of Silver.**

**History.** — Geber (Invent. of Verity, ch. xxi.) describes the method of preparing crystallized nitrate of silver. When this salt is fused, it is named the infernal stone (lapis infernalis) or lunar caustic (causticum mare).

**Preparation.** — In the London Pharmacopoeia it is directed to be prepared by dissolving one ounce and a half of silver in a mixture of one fluidounce of nitric acid and two fluidounces of distilled water. The solution is afterwards to be evaporated to dryness, and the dried nitrate sed and poured into proper moulds.

The fusion may be more readily and safely effected in a Berlin porcelain capsule over a spirit or gas lamp, by means of Griffin’s lamp furnace, than in a crucible over a slow fire, as directed in the Pharmacopoeia.

The theory of the process is readily comprehended. Three equivalents 324 parts of silver abstract three equivalents or 24 parts of oxygen in one equivalent or 54 parts of nitric acid, thereby disengaging one equivalent or 30 parts of binoxide of nitrogen, and forming three equivalents or 348 parts of oxide of silver, which unite with three equivalents or 52 parts of nitric acid to form three equivalents or 510 parts of nitrate of silver.

**Properties.** — Nitrate of silver forms transparent, colourless crystals, whose primary form is the right rhombic prism. Its taste is strongly metallic and bitter. When heated it fuses: if the temperature be increased, decomposition ensues; nitric acid and oxygen are evolved, leaving metallic silver. It is soluble in both water and spirit. It does not liquefies: when exposed to the atmosphere and solar light it blackens, probably from the action of organic matter, hydrosulphuric acid, or water contained in the atmosphere. Mr. Scanlan (Athenæum, Aug. 25, 1838) adds that nitrate of silver in a clean dry glass tube, hermetically sealed, undergoes no change of colour by exposure to solar light: the contact of organic matter readily occasions it to become black.

**Characteristics.** — It is known to be a nitrate by its deflagration when heated on charcoal, and the evolution of nitrous fumes. Its characters as a silver salt have been already described (p. 426).

**Composition.** — Nitrate of silver is thus composed:

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<tr>
<td>Oxide of Silver</td>
<td>1</td>
<td>116</td>
<td>68.23</td>
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<tr>
<td>Nitric Acid</td>
<td>1</td>
<td>54</td>
<td>31.76</td>
</tr>
<tr>
<td>Nitrate of Silver</td>
<td>1</td>
<td>170</td>
<td>99.99</td>
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**Purity.** — Nitrate of silver should be white, and completely soluble in distilled water. By the action of organic matters it blackens from partial reduction. The presence of copper may be detected in its solution by the blue colour produced with caustic ammonia. The watery
solution from which the silver has been thrown down by hydrochloric acid should be unchanged by the addition of hydro sulphuric acid, shewing the absence of lead and copper; and be completely volatilized by heat: if any saline residuum be obtained, the nitrate was adulterated. The white precipitate produced with either hydrochloric acid or chloride of sodium should be readily dissolved by caustic ammonia: if chloride of lead be present the effect will be otherwise.

Physiological Effects. (a.) On animals.—Orfila (Toxicol. Gén.) found that it acted on animals as a powerfully corrosive poison. When dogs were made to swallow it, gastro-enteritis was induced. No symptoms indicating its absorption were observed. Dissolved in water, and thrown into the jugular vein, it produced difficult respiration, convulsive movements, and speedy death.

(b.) On man.—The local action of nitrate of silver is that of a caustic or corrosive. This might be expected, from observing its action on albumen and fibrin—substances which form the principal part of the animal textures. If a solution of nitrate of silver be added to an albuminous liquid, a white curdy precipitate is formed, composed of nitrate of silver and albumen, insoluble in caustic ammonia; and after some time becoming coloured and ultimately blackish, from the partial or complete reduction of the silver: a soluble compound of albumen and nitrate of silver is formed simultaneously with the insoluble one. The action of nitrate of silver on fibrin is analogous to that on albumen: that is, a white compound of nitrate of silver and fibrin is at first formed, but gradually the metal is reduced. These facts assist us in comprehending the nature of the changes produced by the application of nitrate of silver to the different tissues.

Applied to the skin it produces first a white mark (owing to its union with the coagulated albumen of the cuticle): gradually this becomes bluish grey, purple, and ultimately black, owing to the partial reduction of the silver. If the integument be moistened, and the nitrate applied three or four times, it causes at the end of some hours vesication, which is attended with less pain than that produced by cantharides. In some cases it excites acute pain. In one instance in which I applied it freely to the scalp for a cutaneous affection, fever with delirium was produced, which endangered the life of the patient (a girl of six years.) This is deserving of notice, because in Mr. Higgensbottom’s work (Essay on the Use of the Nitrate of Silver, 2d ed. p. 198) we are told that nitrate of silver applied as a vesicant “causes scarcely any constitutional irritation, even in children.” In a few days the black and destroyed cuticle cracks and falls off, without any destruction of the subjacent cutis vera.

Applied to the hair or nails the nitrate stains them black, as in the case of the cuticle; and, in consequence, it is one of the substances employed as a hair-dye. When recently applied, the black tint of the hair, and even of the cuticle, may be removed by washing with a solution of chloride of sodium, and then with ammonia-water, to dissolve the chloride of silver which is produced (Journ. de Chim. Méd. vii. 542.) To detect silver in stained hair, the latter is to be treated with chlorine, by which chloride of silver is produced, which is soluble in ammonia, and precipitable from its solution by nitric acid (Devergie, Méd. Leg. ii. 933.) Part of the black colour of the hair stained by the nitrate probably depends on the formation of sulphuret of silver.
When nitrate of silver is applied to an ulcer it produces a white film owing to its union with the albumen, and perhaps also with the chloride, of the secretion.) This film in a few hours assumes a dark colour, and ultimately forms a black eschar. This hardens, and in few days becomes corrugated, separates at the edges, and at length peels off altogether, leaving the surface of the sore beneath in a healed state (Higginbottom, op. cit. p. 10.) The intensity of the pain varies much in different cases; but is, on the whole, very much less than might be imagined by those who have not tried this remedy.

When applied to mucous membranes, a similar white compound of the nitrate with the animal matter of the secreted mucus is formed, and this defends the living tissue from the action of the caustic, so that the effects are not so violent as might be expected. Thus the solid nitrate may be applied to the mucous surface of the vagina, and even to the os uteri, in cases of leucorrhœa and gonorrhœa, oftentimes without exciting any pain or inflammation: in some instances, however, it produces smarting pain, which lasts for several hours, but no serious effects have resulted from its use, even when, by accident, two drachms of nitrate have been left to dissolve in the vagina. (Dr. Hamay, Lond. Med. Gaz. xx. 185; also Mr. Bell, ibid. 473; and Dr. Jewel, Prat. Observ. on Leucorrhœa.)

Its chemical effects on the other mucous membranes are analogous to those just mentioned; but the pain which it produces varies with different membranes, and in the same membrane under different states. Its application to the conjunctiva is attended with acute pain, especially when inflammation is going on) though in general it soon subsides. On all these surfaces it acts as an astringent.

The safety with which, in most cases, large doses of the nitrate are administered internally, must depend on the presence of the mucus which lines the internal coat of the stomach; the animal matter of which combining with the nitrate prevents its action on the living tissue. It is deserving of especial notice that larger doses may be exhibited without inconveniencing the stomach, in the form of pill, than in that of solution. Dr. Powell (Med. Trans. of the College of Phys. iv. 85) in some cases was enabled to give 15 grains at a dose in the form of pills, while he rarely found stomachs that could bear more than five grains in solution. Bouquier (Dict. Mat. Méd. i. 403) has also remarked the greater activity of the solution. If cautiously exhibited, beginning with small doses and gradually increasing them, it may be exhibited for a considerable period without producing any obvious changes in the corporeal functions, though it may be exercising a beneficial influence over the constitution, evinced by its amelioration of certain diseases, as epilepsy. In some cases it has caused an eruption (Sementini, Quart. Journ. of Science, xii. 189; Copland, Dict. Pract. Med. i. 68.) If the dose be too large it causes gastrodynia, sometimes nausea and vomiting, and occasionally purging. Taken in an excessive dose it acts as a corrosive poison; but cases of this kind are very rarely met with. Boerhaave mentions an instance in which it caused excruciating pain, gangrene, and sphacelus of the first passage.

All the above-mentioned symptoms are referrible to its local action, and from them we have no evidence of its absorption, or of the nature of its influence over the general system. But the discoloration of the skin, presently to be noticed, fully proves that absorption does take place when the medicine is exhibited in small but long-continued doses. It exer-
cises a specific influence over the nervous system; at least I infer this partly from the effects observed by Orsila when it was injected into the veins of animals, and partly from its occasionally curative powers in affections of his system, as epilepsy and chorea.

The blueness, or slate colour, or bronze hue of the skin just alluded to has been produced in several patients who have continued the use of the nitrate during some months or years (Medico-Chirurg. Trans. vii. and ix.) In some of the cases the patients have been cured of the epilepsy for which they took the medicine; in others the remedy has failed (Rayer, Treatise on Skin Diseases, by Willis, 961). In one instance which fell under my notice, the patient, a highly respectable gentleman, residing in London, was obliged to give up business in consequence of the discoloration; for when he went into the street, the boys gathered around him, crying out "there goes the blue man." In this instance no perceptible diminution of the colour had occurred for several years, but in some cases it fades in intensity. The corion is the essential seat of it. Dr. Baddeley (Med.-Chir. Trans. ix. 238) found that blisters rose white,—a proof that in his patient the colouring matter was below the epidermis. But in some instances the cuticle and corpus mucousum of the face and hands participate in the tint. In one instance the mucous membrane of the stomach and intestines was similarly tinted. A case is mentioned by Wedemeyer (Lond. Med. Gaz. iii. 650) of an epileptic who was cured by nitrate of silver, but eventually died of diseased liver and dropsy: all the internal viscera were more or less blue, and Mr. Brande obtained metallic silver from the plexus choroides and pancreas. The discoloration of the skin is usually regarded as permanent and incurable; but I have been informed that in one instance washes of dilute nitric acid diminished it. If this observation be correct, I would suggest the exhibition of nitric acid internally, as well as its external use. Dr. A. T. Thomson (Elem. of Mat. Med. i. 715) suggests that if nitric acid were conjoined with nitrate of silver, the discoloration might be prevented; and the suggestion certainly deserves attention. But I would observe, that if the acid should prove efficacious, his hypothesis, that the colour depends on blackened chloride of silver, will be disproved; for nitric acid can neither prevent the action of the compounds of chlorine on the salts of silver, nor can it dissolve the white chloride or the black subchloride.

Uses.—Nitrate of silver has been employed internally in a very few cases only; and of these the principal and most important are epilepsy, chorea, and angina pectoris. Its liability to discolor the skin is a great drawback to its use; indeed, I conceive that a medical man is not justified in risking the production of this effect without previously informing his patient of the possible result.

In epilepsy it has occasionally, perhaps more frequently than any other remedy, proved successful. Dr. Sims (Mem. of the Med. Soc. of Lond. iv. 379), Drs. Baillie, R. Harrison, Roget, and J. Johnson (Treat. on Nerv. Dis. by J. Cooke, M.D. ii. Pt. 2, 147), have all borne testimony to its beneficial effects. Its methodus medendi is inexplicable. This, indeed, is to be expected, when it is considered that the pathology and causes of epilepsy are so little known, and that, as Dr. Sims has justly observed, every thing concerning this disease is involved in the greatest doubt and obscurity, if we except the descriptions of a single fit, and that it returns at uncertain intervals. In this state of ignorance, and with the already-
tioned facts before us, as to the curative powers of this salt, the
ervation of Georget (Physiol. du Système Nerv. ii. 401), that he has
at difficulty in conciving how the blindest empiricism should have
any one to attempt the cure of a diseased brain by cauterizing the
nach, is, I conceive, most absurd, and unwarranted. The cases
ich have been relieved by it are probably those termed by Dr. M. Hall
ct. on the Nerv. System, p. 143) eccentric. In the few instances in
ich I have seen this remedy tried, it has proved unsuccessful; but
was not continued long, on account of the apprehended discoloration
he skin.

n chorea it has been successfully employed by Dr. Powell (Med.
ns. of the College of Phys. iv. 85), Dr. Uwins (Ed. Med. and Surg.
rn. viii. 407), Dr. Crampton (Trans. of the King and Queen's College
Phys. iv. 114), Lombard (Rust's Magaz. xl.), and others. In angina
oris it has been administered in the intervals of the paroxysms with
sional success by Dr. Cappe (Duncan's Annals of Med. iii.), and by
Copland (op. cit.) In chronic affections of the stomach (especially
bid sensibility of the gastric and intestinal nerves) it has been
ourably spoken of by Antenreith (Dierbach's Neust. Entdeck. in d. Mat.
. 1837, i. 528), Dr. James Johnson (On Indigestion, 2d ed. p. 87),
Rueff (Diebach, op. cit.; also Americ. Journ. of Med. Scien. May
77, p. 225). It has been employed to allay chronic vomiting connected
in disordered innervation, as well as with disease of the stomach
rhus and cancer), and to relieve gastrodynia. The foregoing are the
at important of the diseases against which nitrate of silver has been
istered internally.

an external agent its uses are far more valuable, while they
fre from the danger of staining the skin. It is employed some-
es as a caustic, and as such it has some advantages over potassa fusa
the liquid corrosives. Thus, it does not liquify by its application,
hence its action is confined to the parts with which it is placed in
act. It is used to remove and repress spongy granulations in wounds
ulcers, and to destroy warts, whether venereal or otherwise. It is
lied to chancres on their first appearance, with the view of decom-
ting the syphilitic poison, and thereby of stopping its absorption, and
enting bubo or secondary symptoms. This practice has the sanction
Mr. Hunter. I have several times seen it fail, perhaps because it was
adopted sufficiently early. The nitrate should be scraped to a point,
applied to every part of the ulcer. This mode of treating chancres
been recently brought forward by Ratier (Arch. Gén. de Méd. xv. 47,
vi. 62) as if it were new, and as forming part of Bretonneau's ectrotic
otic, ętokroicos, I abort,) method of treating diseases!

The application of nitrate of silver to punctured wounds is often
ended with most beneficial effects, as Mr. Higginbottom (op. cit.) has
proved. It prevents or subdues inflammatory action in a very
rising manner. It is equally adapted for poisoned as for simple
uds. To promote the healing of ulcers it is a most valuable remedy.
arge indolent ulcers, particularly those of a fistulous or callous kind,
t as a most efficient stimulant. To small ulcers it may be applied
as to cause an eschar, and when at length this peels off, the sore is
ed to be healed. Mr. Higginbottom (op. cit. p. 11,) asserts that "in
y instance in which the eschar remains adherent from the first
application, the wound or ulcer over which it is formed invariably heals. Dry lint will, in general, be found the best dressing for sores touched with the nitrate.

Nitrates of silver was proposed by Mr. Higginbottom as a topical remedy for external inflammation. It may be applied with great advantage to subdue the inflammatory action of erythema, of paronychia or whitlow, and of inflamed absorbents. In some cases it is merely necessary to blacken the cuticle; in others, Mr. Higginbottom recommends it to be used so as to induce vesication. In what way it subdues inflammation—in other words, its methodus medendi—is completely unknown.

Bretonneau and Serres (Arch. Gén. de Méd. viii. 220 and 427) recommend the cauteration of variolous pustules by nitrate of silver, in order to cut short their progress. It is principally useful as a means of preventing pitting, and should be employed on the first or second day of the eruption. The solid caustic is to be applied to each pustule after the apices have been removed. This etiotic method has also been employed in the treatment of shingles (herpes zoster): in one case the disease was cured in a few hours (Arch. Gén. de Méd. xviii. 439). Some good rules for its application have been laid down by Rayer (Treatise on Skin Diseases, by Willis, p. 260).

In some diseases of the eye nitrate of silver is a most valuable remedial agent. It is used in the solid state, in solution, and in ointment: the solution may be used as a wash or injection, or applied by a camel's hair pencil. In deep ulcers of the cornea, the solid nitrate should be applied, in superficial ones, a solution (of from 4 to 10 grains of the salt to an ounce of distilled water) may be employed (Mackenzie, On the Disease of the Eye, 2d ed. 575). There is one drawback to the use of this substance in ulcers of the cornea, as well as other affections of the eye; viz. the danger of producing dark specks in the cornea, or of staining the conjunctiva (Jacob, Dubl. Hosp. Rep. v. 365). In both acute and chronic ophthalmia, Mr. Guthrie (Lond. Med. and Phys. Journ. lx. 193, lixi. 1) employs this salt in the form of ointment (Arg. Nitr. gr. iij. ad gr. x. Liq. Plumbi Subacet. gtt. xv.; Ung. Ceracæi, 3j.) Of this he directs a portion (varying in size from a large pin's head to that of a garden pea) to be introduced between the lids by the finger or a camel's hair pencil. It causes more or less pain, which sometimes lasts only half an hour, and others till next day. Warm anodyne fomentations are to be used; and the application of the ointment repeated every third day. In acute cases two or three applications will arrest the disease. With this treatment blood-letting, and the use of calomel and opium, are preceded or conjoined. (For some judicious remarks on this practice, consult the article Ophthalmia, by Dr. Jacob, in the Cyclop. of Pract. Med. iii. 201.) While many surgeons hesitate to use nitrate of silver in the first stage of acute purulent ophthalmia, all are agreed as to its value in the second stage of the disease, as well as in chronic ophthalmia. Besides the diseases of the eye already mentioned, there are many others in which the oculist finds this salt of the greatest service, as a caustic, astringent, or stimulant. (Vide Dr. Mackenzie's Treat. on Diseases of the Eye; and Mr. Ryall's paper, in the Trans. of the King and Queen's College Phys. v. 1).

In inflammatory affections and ulcerations of the mucous membrane of the mouth and fauces, nitrate of silver is sometimes a most valuable
application (Hunt, Lond. Med. Gaz. xiii. 129). When the fibrinous
induration of croup commences on the surface of the tonsils and arches of
the palate, its further progress may be stopped, according to Mr.
MacKenzie (Edin. Med. and Surg. Journ. xxiii. 294), by the application
of a solution composed of a scruple of nitrate of silver and an ounce of
stilled water. The solid nitrate has been introduced through an aper-
te in the trachea, and applied to ulcers on the inner surface of the
larynx, in a case of phthisis laryngea, with apparent benefit, (Liston, 
Remants of Surgery, part ii. p. 256).
In some forms of leucorrhoæ the application of nitrate of silver, either
the solid state or in solution, is attended with beneficial effects. This
practice was first recommended by Dr. Jewel (Pract. Observ. on
leucorrhoæ, 1830). It is, I believe, most successful in cases dependent
on local irritation or subacute inflammation, and not arising from consti-
tutional debility. The solution may be applied by a piece of lint or
orange, or may be injected by means of a syringe with a curved pipe.
Strength must vary according to circumstances. Dr. Jewel generally
employs three grains of the nitrate to an ounce of water; but in the Lock
hospital, solutions are sometimes used containing half a drachm or even
four scruplets to the ounce. In some cases the solid nitrate has been
applied to the cervix uteri and vagina by means of a silver tube. In
gonorrhoea of the female a solution of nitrate of silver, or even this caustic
the solid state, has been used with the best effects. It was first
employed by Dr. Jewel, but subsequently, and on a much more extended
scale, by Dr. Hannay (Lond. Med. Gaz. xx. 185), and without any
serious consequences. In many cases the discharge ceased, never to
return, in twenty-four hours. The fear of ill effects has prevented the
universal adoption of this practice. In gonorrhoea of the male, the intro-
duction of a bougie, smeared with an ointment of nitrate of silver, is, occa-
ionally, a most effectual cure; but the practice is dangerous. In one
case I saw acute and nearly fatal urethritis brought on by its employ-
ment. The individual was a dresser at one of the London hospitals, and
had practised this mode of treatment in many instances on the hospital
patients with the happiest results. An aqueous solution of the salt has
been successfully used in chronic gonorrhœa (Rognetta, Lancette Fran-
çaise, Mar. 31, 1836).
In fissured or excoriated nipples the application of the solid nitrate of
silver is of great service. It should be insinuated into all the chaps or
chaps, and the nipple afterwards washed with tepid milk and water.
The application of solid nitrate of silver is a most effectual remedy for
different forms of porrigo which affect the heads of children. The
scab should be well rubbed into the parts. I have never known the
scab to fail, or to cause the loss of hair. Where the greater portion of
the scalp is involved, the different spots should be cauterized successively
at intervals of some days; for, as already mentioned, I have seen fever
delirium produced in a child from the too extensive use of the
medicament. In psoriasis the same medicine was found by Dr. Graves
(Lond. Med. Gaz. vii. 520) most effectual. An aqueous solution of the
silver is also valuable as an astringent wash in other skin diseases, as
psoriasis. The solid nitrate is sometimes employed to stop the progress
of irritative or erysipelas inflammation, by applying it in a circular
form around, and at a little distance from, the inflamed portion; but I have frequently observed the inflammation extend beyond the cauterized part. Mr. Higginbottom (op. cit.) reports favourably of the effects of applying the nitrate to burns and scalds; and his observations have been confirmed by those of Mr. Cox (Lond. Med. Gaz. x. 672).

In strictures of the urethra and oesophagus, bougies armed with lunar caustic in their points (the caustic or armed bougie) are occasionally employed with great advantage, at least in urethral stricture. When the common bougie (cerculus simplex) is formed, the point of it should be heated with a conicel piercer, and the caustic introduced while the composition is quite soft. The point of the bougie should then be rubbed smooth on a piece of polished marble till no inequality in the size of it appear (Dr. Andrews, Observ. on the Applic. of Lunar Caustic to Strictures, 1807, p. 126.) Notwithstanding that the application of nitrate of silver to stricture of the urethra has been advocated by Mr. Hunter, Sir E. Home, Mr. Wilson, Dr. Andrews, and others, it is now but little employed; yet of its efficacy and safety in many obstinate cases, where the simple bougie fails, I am assured by repeated observation. It is commonly supposed that it acts by burning or destroying the stricture; such is not the fact. It induces some change in the vital actions of the part, which is followed by relaxation of the narrowed portion of the canal, but which change is as difficult to explain as is the subduction of external inflammatory action by the application of this salt. Of the use of the caustic bougie in stricture of the oesophagus I have no experience.

Administration.—Nitrate of silver may be exhibited in doses of \( \frac{1}{2} \) of a grain, gradually increased to three or four grains, three times a day. As before mentioned, Dr. Powell has augmented the dose to fifteen grains. The usual mode of administering it is in the form of pills made of breadcrumb; but the chloride of sodium, which this contains, renders it objectionable: some mild vegetable powder with mucilage is preferable. Common salt or salted foods should not be taken either immediately before or after swallowing these pills. Dr. Johnson (Essay on Morbid Sensibility of the Stomach and Bowels, 2d ed. p. 90), asserts "that there is no instance on record where the complexion has been affected by the medicine when restricted to three months' administration." It is advisable, however, not to continue the use of it beyond a month or six weeks at a time.

For external use an aqueous solution is employed of strengths varying from a quarter of a grain to two scrupulæ, in an ounce of distilled water. The formula for Mr. Guthrie's ointment has already been given.

Liquor Argentum Nitratis, Ph. Lond. (Nitrate of silver, \( \frac{1}{2} \)j of distilled water, \( \frac{2}{3} \)j dissolve and strain. The solution is to be preserved from the light in a well-closed vessel.) It has been introduced into the Pharmacopoeia merely as a test.

Antidote.—The antidote for nitrate of silver is common salt (chloride of sodium.) When this comes in contact with lunar caustic, nitrate of soda and chloride of silver are produced: the latter compound is, according to the experiments of Orfila (Toxicol. Gén.), innoxious; though it has been said to possess antisyphilitic powers (Serre, Lond. Med. Gaz. xvi. 703) The contents of the stomach should be removed, and the inflammatory symptoms combated by demulcents, bloodletting, and the usual anti phlogistic means.
When the local use of nitrate of silver causes excessive pain, relief may be gained by washing the parts with a solution of common salt. Eces of caustic have been left in the vagina and urethra without unpleasant consequences resulting. Injections of a solution of common salt are the best means of preventing bad effects.

To diminish the slate-coloured tint of the skin arising from nitrate of silver, acids or the super-salts offer the most probable means of success. The external and internal use of dilute nitric acid, or the internal employment of bitartrate of potash, may be tried: the discoloration is said to have yielded to a steady course of the last-mentioned substance (United States Dispensatory).

_Ar genti Cyan'idum._—‘Cy’anide of Silver.

_History._—This compound, sometimes called hydrocyanate, cyanuret, cyanodide of silver, or argentum zootinicum, has been studied by Heele, Ittner, and Gay-Lussac.

_Preparation._—In the London Pharmacopoeia this compound is directed to be prepared by adding a pint (fxx.) of diluted hydrocyanic acid to a solution of two ounces and two drachms of nitrate of silver in a pint of distilled water. The precipitate is to be washed with distilled water, and dried.

In this process one equivalent, or 27 parts of hydrocyanic acid react with one equivalent, or 170 parts of nitrate of silver: thereby generating one equivalent, or 134 parts of cyanide of silver, and one equivalent, or 108 parts of water, and setting free one equivalent, or 54 parts of nitric acid.

<table>
<thead>
<tr>
<th>Reagents</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Nitric Acid</td>
<td>54</td>
</tr>
<tr>
<td>1 eq. Oxygen</td>
<td>2</td>
</tr>
<tr>
<td>1 eq. Water</td>
<td>108</td>
</tr>
<tr>
<td>1 eq. Silver</td>
<td>1</td>
</tr>
<tr>
<td>1 eq. Cyanogen</td>
<td>26</td>
</tr>
<tr>
<td>1 eq. Cyanide Silver</td>
<td>134</td>
</tr>
</tbody>
</table>

_PROPERTIES._—When first thrown down it is a white curdy precipitate, which by drying becomes pulverent. It is insipid, insoluble in water, and dissolves in caustic ammonia. It is decomposed by hydrochloric and hydrosulphuric acid, both of which develop with it hydrocyanic acid. It combines with other metallic cyanides to form the argentocyanides. By exposure to the atmosphere and solar rays it assumes a bluish tint. It is not decomposed by mixture with neutral vegetable substances (Journ. de Chim. Med. 2nd Ser. iii. 407.)

_CHARACTERISTICS._—It is insoluble in cold nitric acid, but soluble in boiling acid. When carefully dried and then heated in a glass tube yields cyanogen gas (which is readily known by its combustibility and bluish-red colour of its flame) and a residuum of metallic silver. The latter is recognised by the before-mentioned tests for this metal.

_COMPOSITION._—The following is the composition of this substance:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver</td>
<td>1</td>
<td>108</td>
</tr>
<tr>
<td>Cyanogen</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>Cyanide of Silver</td>
<td>1</td>
<td>134</td>
</tr>
</tbody>
</table>

_PHYSIOLOGICAL EFFECTS AND USES._—I am unacquainted with any experiments made to determine its effects on man or animals. Serre, of
Montpellier (Journ. de Chim. Méd. 2nde Ser. iii. 408) gave it in syphilitic maladies, in doses of one-tenth and even of one-eighth of a grain, without the least inconvenience. It has been introduced into the London Pharmacopoeia, at the suggestion of Mr. Everitt, as a source of hydrocyanic acid (vide p. 237.)

ORDER 20. MERCURY AND ITS COMPOUNDS.

Hydraz'gyrum.—Mer'cury or Quick'silver.

History.—No mention is made of quicksilver in the Old Testament nor does Herodotus allude to it. From this we might infer that both the ancient Hebrews and Egyptians were unacquainted with it. But we are told on the authority of an Oriental writer, that the Egyptian magicians in their attempts to imitate the miracles of Moses, employed wands and cords containing mercury, which under the influence of the solar heat imitated the motion of serpents (D'Herbelot, Bibliothèque Orient. art Moussaa). Both Aristotle and Theophrastus (De Lapidibus) mention ἀργυρόσις χρώς, (argentum liquidum) : and the first of these naturalists says that Daedalus (who is supposed to have lived about 1300 years before Christ) communicated a power of motion to a wooden Venus by pouring quicksilver into it. We are also told that Daedalus was taught this art by the priests of Memphis. Pliny (Hist. Nat. lib. xxxiii.) and Dioscorides (lib. v. cap. ex.) also speak of mercury, and the latter writer describes the method of obtaining it from cinnabar.

Mercury was first employed medicinally by the Arabian physician Avicenna and Rhazes; but they only ventured to use it externally against vermin and cutaneous diseases. We are indebted to that renowned empiric Paracelsus for its administration internally.

Synonymes.—The names by which this metal has been distinguished are numerous. Some have reference to its silvery appearance and liquid form; as ἴδωρἀργυρος, hydrargyrus and hydrargyrum, (from ὅρος, aqua, and ἴδωρἀργυρος, silver); others to its mobility and liquidity, as well as its similarity to silver, such as argentum vivum, aqua argentea, aqua metal lorum, and quicksilver. It has been called Mercury, after the message of the gods, on account of its volatility.

Natural History.—Mercury is comparatively a rare substance. It is found in the metallic state, either pure (native or virgin mercury), in the form of globules, in the cavities of the other ores of this metal, or combined with silver (native amalgam). Bisulphuret of mercury (native cinnabar) is the most important of the quicksilver ores, since the metal of commerce is chiefly obtained from it. The principal mines of it are those of Idria in Carniola, and Almaden in Spain. The latter yielded 10,000 lbs. of cinnabar annually to Rome in the time of Pliny (Hist. Nat. xxxiii.) Protochloride of mercury (mercurial horn ore or corneous mercury) is another of the ores of mercury. Traces of this metal have also been met with in common salt, during its distillation with sulphuric acid by Ronelle, Proust, Westrumb, and Wurzer (Gmelin, Handb. d. Chemi. i. 1282).

Preparation.—The extraction of quicksilver is very simple. In some places (as in the Palatinate and the duchy of Deux-Ponts) the native cinnabar is mixed with caustic lime, and distilled in iron retorts. In
is process the lime abstracts the sulphur (forming sulphuret of calcium), and the disengaged mercury distils over. At Almaden the ore is roasted, which the sulphur is converted into sulphurous acid, and the mercury volatilized. At Idria a modification of this process is followed (Dumas, "Traité de Chimie," iv. 305).

COMMERCE. — Quicksilver is imported in cylindrical, wrought-iron bottles (holding from 60 lbs. to 1 cwt.), the mouth of each being closed by an iron screw; and also in goat-skins, two or three times doubled. The quantities imported in the years 1827 and 1830, and the places from which the metal was brought, are thus stated in the parliamentary papers (Statement of Imports and Exports, for 1827 and 1830).

<table>
<thead>
<tr>
<th>Year</th>
<th>Spain and the Balearic Islands</th>
<th>Gibraltar</th>
<th>Italy and the Italian Islands</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1827</td>
<td>653,374</td>
<td>121,320</td>
<td>108,567</td>
<td>883,261</td>
</tr>
<tr>
<td>1830</td>
<td>1,675,652</td>
<td>—</td>
<td>331,416</td>
<td>2,007,068</td>
</tr>
</tbody>
</table>

PROPERTIES. — At ordinary temperatures quicksilver is an odourless, tasteless, liquid metal, having a whitish colour, like silver or tin. Its specific gravity is 13·5 or 13·6. When intimately mixed with pulverent or fatty bodies, it loses its liquid character, and it is then said to be killed, extinguished, or mortified. When cooled down to 38·6° F. it freezes, and crystallizes in needles and regular octahedrons. In this state it is ductile, malleable, and tenacious. At 656° F. it boils, and produces an invisible elastic vapour, whose specific gravity is 6·976. Mr. Faraday (Quart. Journ. Science, x. 354) has shown, that at common temperatures, and even when the air is present, mercury is always surrounded by a mercurial atmosphere; and, according to Stromeyer, at from 140° F. to 160° F. mercury, when mixed with water, is volatilized in considerable quantities. Chemists are not agreed as to the equivalent or atomic weight of this metal. Thus Dr. Thomson assumes 100; Gmelin, 101; Berzelius, 111·48; Brande, 200; Turner and Phillips, 202. I shall adopt the latter.

CHARACTERISTICS. (a.) Of metallic mercury.—In its metallic state mercury is distinguished by its liquidity at common temperatures, and its volatility. When invisible to the naked eye, and in a finely divided state, it may be readily detected by the white stain (called by workmen "blackening") communicated to gold and silver. Mercurial vapour may be detected by exposing gold or silver to its influence. If mercury be in combination with other metals, and the tests now mentioned be not applicable, we may dissolve the suspected substance in nitric acid, and proceed as for the mercurial salts.

(b.) Of mercurial compounds.—When heated with potash or soda, or their carbonates, globules of metallic mercury are obtained, which may be recognised by the properties already described. Solutions of the mercurial salts, placed for some time in contact with a piece of bright copper, and afterwards rubbed off with paper, leave a silvery stain behind, which disappears when heated to redness. Those compounds which are of themselves insoluble in water may be dissolved by digesting them with nitric acid; and the copper test may then be applied. In this way the mercury contained in calomel, vermilion, subsulphate and iodide
of mercury, may be readily recognised. Sulphuretted hydrogen produces, with mercurial solutions, a black precipitate.

Solutions of the protosalts of mercury yield, with caustic potash or soda, a grey or black precipitate; and, with iodide of potassium, a greenish or yellow precipitate.

Solutions of the persalts yield, with caustic potash or soda, a yellow or reddish precipitate; and, with iodide of potassium, a scarlet one.

Purity.—The purity of this metal is ascertained by its brilliancy and great mobility. Mechanical impurities—such as adhering dirt or dust—are instantly detected, and may be separated by straining through filter, or by filtering through a small hole in the apex of an inverted cone of paper. The presence of lead, tin, zinc, or bismuth, may be suspected by the rapidity with which the metal tarnishes in the air, and by its small parts tailing, instead of preserving a spherical form. These impurities may be got rid of by distillation in an earthen retort.

Physiological Effects. 1. Of Metallic Mercury. (a.) On vegetables.—Mercurial vapours are fatal to plants (Decandolle, Phys. Vég. 1332).

(b.) On animals.—From the experiments of Moulin (Phil. Trans. for 1691, No. 192), Haighton (Beddoes, On Pulmonary Consumption, 1799), Viborg (quoted by Wibmer, Wirkung d. Arzneim. iii. 88), and Gaspard (Magendie, Journ. de Physiol. i.), it appears that when injected into the veins, mercury collects in the small vessels of the neighbouring organs, and acts as a mechanical irritant. Thus, if thrown into the jugular vein, peripneumonia is excited; and, on examination after death, little abscesses and tubercles have been found in the lungs, in each of which was a globule of quicksilver as the nucleus.

(c.) On man.—Some difference of opinion exists as to the effects of liquid mercury when swallowed; one party asserting that it is poisonous, another that it is innocuous. The truth I believe to be this: so long as it retains the metallic state it is inert; but it sometimes combines with oxygen in the alimentary canal, and in this way acquires activity. Avicenna, Fallopius, and Brasavola, declared it harmless; Sue (Mém. de la Facult. Méd. d'Émulat. 4th year, p. 252) states that a patient took for a long time two pounds daily without injury; and I could refer to the experience of many others who have seen it employed in obstructions of the bowels, without proving noxious; but the fact is so generally known and admitted, as to require no further notice. In some instances, however, it has acted powerfully, more especially where it has been retained in the bowels for a considerable time; no doubt from becoming oxidized. Thus Zwinger (Miscell. Curiosa Decur. 2nd Ann. 6, 1688) states that four ounces brought on profuse salivation four days after swallowing it. Laborde (Journ. de Méd. i. 3) also tells us, that a man who retained seven ounces in his body for fourteen days, was attacked with profuse salivation, ulceration of the mouth, and paralysis of the extremities; and other cases of a similar kind might be quoted.

Dr. Christison considers the question set at rest by the Berlin College of Physicians, and that the metal is innocuous.

Applied externally, liquid mercury has sometimes produced bad effects. Dr. Scheel has related a fatal case, attended with salivation, brought on from wearing at the breast during six years a leathern bag, containing a
MERCURY OR QUICKSILVER.

Dr. Buchner, in the "Journal de Méd.," says "The injurious effects of mercurial vapours, when inhaled or otherwise applied to the body, have been long known. They are observed in water distillers, looking-glass silverers, barometer-makers, workmen employed in quicksilver mines, and in others exposed to mercurial emanations. In most instances an affection of the nervous system is brought on, and which is indicated by the shaking palsy or tremblement mercurial (tremor mercurialis), which is sometimes attended with stammering (psellismus stallicus), vertigo, loss of memory, and other cerebral disorders, which subsequently terminate fatally. The first symptom of shaking palsy is unsteadiness of the arm, succeeded by a kind of quivering of the muscles, which increases until the movements become of a convulsive character. In all the cases (about five or six in number) which have fallen under my notice, the shaking ceased during sleep. I have not seen the least benefit obtained by remedial means, although various modes of treatment were tried. This is not in accordance with the experience of Dr. Christison, who says the tremors "are cured easily though slowly." If the individual continue his business, other more dangerous symptoms come on, such as chloridure of mercury or epilepsy, or apoplexy (apoplexia mercurialis); and ultimately death takes place.

In some instances salivation, ulceration of the mouth, and hæmoptysis, are produced by the vapour of mercury. The following remarkable case can instance in point. In 1810, the Triumph man-of-war, and Phipps sloop, received on board several tons of quicksilver, saved from the wreck of a vessel near Cadiz. In consequence of the rotting of the bags the mercury escaped, and the whole of the crews became more or less infected. In the space of three weeks 200 men were salivated, two died, and all the animals, cats, dogs, sheep, goats, fowls, a canary bird,—nay, even the rats, mice, and cock-roaches, were destroyed (Ed. Med. and Surg. Journ. xxvi. 29).

As metallic mercury in the liquid state is not active, it has been thought that mercurial vapour must also be inactive. Thus Dr. Christison thinks that the activity of the emanations arises from the oxidation of the metal before it is inhaled. I believe, however, with Buchner (Toxicologie), Orfila (Toxicol. Gén.), and others, that metallic mercury, in the finely divided state in which it must exist as vapour, is itself poisonous.

2. OF MERCURIAL COMPOUNDS.—Probably all the mercurial compounds are more or less noxious. The only doubtful exception to this is the case of the sulphurets of this metal, which, according to Orfila (Arch. Gén. de Méd. xix. 330), are inert.

(a.) Local effects.—For the most part, the local action of the mercurial compounds may be regarded as alterative, and more or less irritant. Many of the preparations (as the bichloide, the nitrates, &c.) are energetic astringics. The protoxide and protochloride (calomel) are very slightly irritant only: indeed, Mr. Annesley (Diseases of India) asserts, from his experiments on dogs, and his experience with it in the human subject, at the latter substance is the reverse of an irritant; in other words, when applied to the gastro-intestinal membrane it diminishes its sensibility. But I suspect some error of observation here.

(b.) Remote effects.—In small and repeated doses, the first obvious effect of mercurials is an increased activity in the secreting and exhaling
apparatus. This is particularly observed in the digestive organs; the quantity of intestinal mucus, of bile, of saliva, of mucus of the mouth, and probably of pancreatic liquid, being augmented. The alvine discharges become more liquid, and contain a larger proportion of bile. The operation of the medicine does not stop here: the pulmonary, urino-genital, and conjunctival membranes, become moister, the urine is increased in quantity, the catamenial discharge is sometimes brought on, the skin becomes damper and at the same time warmer. The absorbent or lymphatic system seems also to be stimulated to increased activity; for we frequently observe that the accumulations of fluid in the shut membranes (as the pleura, the peritoneum, the arachnoid, and synovial membranes) diminish in quantity, and in some cases rapidly disappear. At the same time, also, glandular swellings and indurations of various kinds are dispersed. These are the cases in which the mercurials are called alteratives—that is, they indirectly induce healthy action in a very slow, gradual, and incomprehensible manner.

When our object is to obtain the sialogogue operation of mercurials, we give them in somewhat larger doses. To a certain extent the effects are the same as those already mentioned, but more intense. Of all the secretions, none are so uniformly and remarkably augmented as those of the mucous follicles of the mouth and the salivary glands; and the increased secretion of these parts is accompanied with more or less tenderness and inflammation, the whole constituting what is termed salivation or ptyalism (salivatio, ptyalismus, sialismus). The first symptoms of this affection are slight tenderness and tumefaction of the gums, which acquire a pale rose colour, except at the edges surrounding the teeth, where they are deep red. Gradually the mouth becomes exceedingly sore, and the tongue much swollen; a coppery taste is perceived, and the breath acquires a remarkable fetidity. The salivary glands soon become tender and swollen; the saliva and mucus of the mouth flow abundantly, sometimes to the extent of several pints in the twenty-four hours. During this state, the fat is rapidly absorbed, and the patient becomes exceedingly emaciated. The blood when drawn from a vein puts on the same appearance as it does in inflammatory diseases. The quantity of saliva and buccal mucus discharged by patients under the influence of mercury, varies according to the quantity of the medicine employed, the susceptibility of the patient, &c. Formerly salivation was carried to a much greater extent than it is at the present day. Thus Boerhaave (Aphorismi) considers a patient should spit three or four pounds in twenty-four hours; and Turner (Pract. Dissert. on the Ven. Disease, 1737) says from two to three quarts are "a good and sufficient discharge." Modern experience has shewn that all the good effects of mercurials may be gained by a very slight affection of the mouth. Several analyses have been made of saliva from patients under the influence of mercury. Fourcroy, Thomson, Bostock, and Devergie, failed to detect the least trace of mercury in it. But some other persons have been more successful, as will be hereafter mentioned. The following are the constituents of saliva during mercurial ptyalism, according to Dr. Thomson (Annal. of Phil. vi. 397):—
Coagulated Albumen ........................................ 0.257
Mucus, with a little Albumen ................................ 0.367
Chloride of Sodium .......................................... 0.090
Water .................................................................. 99.286

100.000

It was an opal fluid, having a sp. gr. of 1.0038, and by standing
produced copious precipitates with it; but the ferrocyanuret of
assassin and infusion of galls had no effect on it. Dr. Bostock
*edico-Chirurg. Trans. xiii. 73* found the saliva discharged under the
fluence of mercury to differ from that of the healthy state, in being less
and in containing a substance analogous to coagulated albumen,
le as it exists in the serum of the blood; so that it would seem the
curial action alters the secretion of the salivary glands, and makes it
analogous to the exhaled fluids of the serous membranes.

The effects of mercury hitherto described are such as are occasionally
duced for the cure of diseases; but occasionally other phenomena
sent themselves in individuals who have been subjected to the influ-
ce of this metal, and which have been considered as constituting a
uliar malady, to which the name of *mercurial disease* (morbus mercu-
alis, hydroargyrias is or hydrargyrosis, cachexia mercuralis, &c.) has
n given. The *pseudo-syphilis*, or *cachexia sypholoidea* of some writers,
supposed to be syphilis, more or less modified by the mercurial disease.

The following are the ill effects which have been ascribed to this metal,
which Dieterich (*Die Merkuriakrankheit, 1837*) regards as so many
ons of the mercurial disease:—

**Mercurial fever (febris mercuralis, Dieter.)**—Under this name Dieterich has
ded two febrile states. One of these (febris erethica; f. salivosa) comes on a
days after the use of large doses of mercury, and is characterized by great rest-
dreness, dryness of the mouth, headache, loss of appetite, nausea, hot and dry skin, quick
re, red gums, swollen tongue, &c.: it usually terminates in a critical discharge (as
usalvation, purging, or sweating), or an eruption makes its appearance. The
scription which Mr. Pearson (*Observe. on the Effects of various Articles of the Mat.
. p. 131*) denominated *mercurial erethism* (erethismus mercuralis), is regarded by
ierich as an adynamic mercurial fever (febris adynamica). It is characterized by
at depression of strength, a sense of anxiety about the precordia, frequent sighing,
ing, partial or universal, a small quick pulse, sometimes vomiting, a pale con-
tenance, a sense of coldness; but the tongue is seldom furred, nor are the
atural functions much disordered. When these symptoms are present, a sudden
ient exertion of the animal power will occasionally prove fatal.

**Excessive salivation (pyialismus stomachalis mercuralis, Dieter. stomatis).**—I
already noticed mercurial salivation as far as it is ever purposely induced for the
of diseases. But it sometimes happens, either from the inordinate employment of
cury, or from some peculiarity in the constitution of the patient, that the mouth
omes violently affected: the gums are tumefied and ulcerated; the tongue is swollen
an extent, that it hangs out of the mouth, incapacitating the patient from either
ng or speaking; the salivary glands are enlarged and most painful, and the saliva
oscopiously from the mouth. In one instance sixteen pounds are said to have
vacuated in twenty-four hours. In some cases (Dieterich, *op. cit.*), the gums
gh, the teeth loosen and drop out, and occasionally necrosis of the alveolar process
place. During this time the system becomes extremely debilitated and ema-
ed; and, if no intermission be given to the use of mercury, involuntary actions of
uscular system come on, and the patient ultimately dies of exhaustion.

In some cases, active inflammation, succeeded by ulceration and sloughing of the
takes place (angina mercuralis). In one instance, which fell under my notice,
condition was brought on by the use of a few grains of blue pill, taken for a liver
ant. Recovery took place, but the contraction of the mucous membrane in the
ighbourhood of the anterior arches of the palate was so great, that the patient was
unable to open her mouth wider than half an inch. Several operations were performed by different surgeons, to remedy this, but the relief was only temporary.

Salivation is occasionally induced by other substances (hydrocyanic, nitric, or arsenious acids, emetic tartar, foxglove, iodine, &c.), and sometimes occurs spontaneously. The peculiar odour of the breath, the brassy or coppery taste, and the spongiousness of the gums, are usually considered to be characteristic of mercurial salivation. But in some cases these symptoms are insufficient to enable us to distinguish it. I have seen about a dozen instances of apparently spontaneous salivation, yet presenting the character of ptysialism from mercury. They occurred in Dispensary patients, and mostly in females. The greater part of them had not (according to their own account) taken medicine of any kind for months. Sloughing phagedena of the mouth (stomatace gangrenosa) cannot, in some cases, be distinguished from the sloughing produced by mercury (stomatace mercurialis). A remarkable case, in proof, I have recorded in the London Medical Gazette (vol. xviii. 389).

3. Mercurial purging (diarrhea mercurialis).—Violent purging is a very frequent consequence of the use of mercury. It is frequently attended with griping, and sometimes with sanguineous evacuations. In some cases there is fullness of the left hypochondrium, burning pain and tenderness of the region of the pancreas, and the evacuations are frothy, whitish, tough, and often greenish, at least in the commencement from the intermixed bile. These symptoms may fairly be referred to an affection of the pancreas, analogous to that of the salivary glands. Dieterich (op. cit.) terms it ptysialismus pancreaticus mercurialis (diarrhoea salivalis, siotorrhea alvea, ptysialismus abdominalis).

4. Urorrhcea mercurialis.—Excessive secretion of urine, from the use of mercury, is very rare. Two cases only are recorded, both by Schlichting (Ephemerid. A.C.L. Nuremburge, 1748, tom. viii. Obs. viii. p. 25, quoted by Dieterich, op. cit.)

5. Hicordis mercurialis.—Profuse sweating is another occasional effect of mercury.

6. Skin diseases.—Several forms of skin diseases, both acute and chronic, have been regarded as part of the ill effects of mercury.

(a.) Ecchyma mercuriale, Pearson; (erythema mercuriale, Spens and Mullins; lepra mercurialis, Stokes and Moriarity; hydrargyrria, Alley, Bayer; erysipelas mercuriale, Cullerier, Lagneau; spilosis mercurialis, Schmaiz).—This disease appears occasionally during the progress of a mercurial course. Some writers have frequently met with it:—thus, Alley (Observ. on the Hydrargyrria, 1810) saw forty-three cases in ten years, and of this number eight terminated fatally. Rayer confesses, that in twenty years he never saw but three instances of it. During the ten years that I was connected with the General Dispensary, I saw only two cases of it. The disease consists of innumerable, minute, and pellicled vesicles, which have been mistaken for pappulae. These give the appearance of a diffused redness to the skin, and a sensation of roughness to the touch. Sometimes it is preceded, and attended by febrile disorder. In two or three days the vesicles attain the size of a pin's head, and the included serum becomes opaque and milky. It soon extends over the body, and is accompanied by tumefaction, tenderness, and itching. It usually terminates by desquamation: but in some cases a copious discharge takes place from the excitiated and tender surface; and when this ceases, the epidermis comes off in large flakes; in some instances the hair and nails fall off, and the eyes and eyebrows become entirely denuded. There is usually some affection of the respiratory organs, indicated by dry cough and tightness of the precordia.

(b.) Militaria mercurialis.—A miliary eruption has been observed by both Peter Frank and Dieterich, apparently as a consequence of the use of mercury.

(c.) Chronic skin diseases (herpes, psyradia, and impetigo).—These are doubtful consequences of the use of mercury. They have occurred after the employment of the metal; but considerable doubt exists, as to whether they ought to be regarded as the effect of the remedy, or of the disease for which they have been exhibited, or of some other condition of system. Herpes preputialis has been ascribed, by Mr. Pearson, to the previous use of mercury (Bateman, Pract. Synopsis of Cutaneous Diseases, 6th ed.), and his opinion has been adopted by Dieterich (op. cit.); but it certainly now and then occurs, when no mercury has been exhibited. The psyradia mercurialis and impetigo mercurialis of Dieterich (op. cit.) are still more doubtful effects of mercury.

7. Inflammation of the eye, fauces, and periostea, have been ascribed by some writers to the use of mercury; but by others the power of this agent to produce these diseases is denied. That they have followed the use of mercury cannot be doubted, but post hoc is not ergo proper hoc. Dieterich regards the maladies referred to as states of congestion, not of inflammation, and therefore calls them symphories (from συμφόρος, συμφορα, συμφορία, συμφορή, συμφορία).
The inflammation of the conjunctiva (conjunctivitis mercurialis; sym-
phritis conjunctivae oculi mercurialis, Dieter), ascribed by Von Ammon (Rust's Maga-
1830) to the use of mercury, should probably be referred to some other cause. He
is it characterized by a lilac taint around the cornea; that it sometimes precedes
dissipation, disappearing when this is established, and is commonly regarded as a
rhaphal symptom. The mercurial iritis (iritis mercurialis: symphritis irres mercuri-
s, Dieter; iritis rheumatico-mercurialis, Jaeger), described by Mr. Travers
surgical Essays, i. 59), was, in all probability, an iritis arising from some other cause
a mercury (Mackenzie, On Diseases of the Eye, 2d edit. p. 496). The so-called mer-
retinitis (symphritis retinae oculi mercurialis, Dieter) may be explained in the
way. An inflammation of the fauces sometimes occurs after the use of mercury
ina mercurialis; symphritis faucium mercurialis, Dieter.) It may come on in five
six days after the use of mercury, and assume an acute form, with a tendency to
gh (Colles, Pract. Observ. on the Vener. Disease, p. 45); or it may appear after the
pment of mercury for five or six weeks, and take on a chronic form (Dieterich,
cit. p. 273). Inflammation of the bocu or periosteo, and the consequent
of nodes (symphritis periostei mercurialis, Dieter.), has been ascribed to mercury.
the disease is rarely or never seen after the use of this mineral, except when it has
en given for the cure of a venereal affection, to which, in fact, it ought with more pro-
ty to be referred (Mr. Lawrence, Lect. on Surg. in Med. Gaz. v. 805; Colles, op.
p. 189).
1. Hypertrophies (Hypertrophie, Dieter.)—Enlargement of the inguinal, axillary,
enteric absorbent glands (adenophyina inguinales mercuriae; ad. axillares merc. ;
ericuriales merc. Dieter.), as well as of some of the secreting glands, viz. the
it glands, the panerases, the testicles, and liver (adenophyina parotidum merc.; ad.
ecuriales merc.; ad. testiculi merc.; hepaticum merc.), and condyloma and
ion (condyloma et ganglion mercuriale, Dieter.), have been ascribed by some
bus, op. cit. and Dieterich, op. cit.) to the use of mercury, but, as I believe, on in-
icient grounds.
2. Ulceration and sloughing.—Ulceration of the mouth is a well-known effect of
cury. Ulceration of the throat is likewise a consequence of the use of this mineral
curial ulcerated throat, Mathias; mercurial sore throat, Bacoit, in Med. Gaz. iii.
. Sloughing of the same parts may also be induced. It is well known that
eral sores (especially those called phagedenic) at times assume a sloughing dispo-
on, in consequence of the improper use of mercury (Sir A. Cooper, Lectures on Sur-
, in Lancet, iv. 42; Carmichael, On Venereal Diseases, p. 165, et seq. 2nd ed.)
eration of the fibrous membranes (ulcus membrana fibrosa mercuriale), and ulceration
the absorbent glands (ulcus glandularum mercuriale), has been ascribed to the use of
cury (Dieterich, op. cit. p. 376).
3. Neuroses mercuriales.—Various symptoms indicating a disordered condition of
ervous system, are met with in persons who have been exposed to the baneful in-
fluence of mercury: such as wandering pains (neuralgia mercurialis); a tremulous
ition of the muscular system (tremor mercurialis), sometimes accompanied with
mering (psallismus metallicus), and occasionally terminating in paralysis (paralysis
urialis), epilepsy or apoplexy (apoplexia mercurialis). To these, Dieterich (op. cit.)
has asthma (asthma mercurialis), of which he only saw one case, amaurosis (amaurosis
urialis), and hypochondriasis (hypochondriasis mercurialis).
Of these, the best known is the shaking palsy (tremor mercurialis: tremblment mer-
el), a remarkable affection which occurs among workmen exposed to the action of the
our of mercury, such as miners, gilders, barometer-makers, looking-glass silvers,
The first symptom of it is unsteadiness of the arm, succeeded by a kind of quiver-
of the muscles, which increases until the movements become of a convulsive charac-
In all the cases which I have seen, the movements were suspended during sleep.
1. Cachexia (cachexia mercurialis).—This condition is characterized by disorder of
digestive organs, loss of appetite, wasting, incapability of much exertion, with in-
used secretion from all the organs, especially from the salivary glands.
The foregoing are the most important of the ill effects ascribed to the
of mercury. As I have already stated, some of them ought probably be referred to other causes, and not to the use of this mineral; but as
ibt must necessarily be entertained on this point, I have thought more advisable to mention them. The student will find some pertinent
ervations concerning them, in a paper by Dr. Musgrave (Edin. Med.
and Sury. Journ. vol. xxviii.), and in Dr. Currie's pamphlet (Examination of the Prejudice commonly entertained against Mercury).

In excessive doses: acute poisoning.—When large doses of some of the soluble salts of mercury have been swallowed, gastro-enteritis is observed. The patient complains of an acrid styptic taste in the mouth and of a feeling of burning and tightness in the throat; the face is usually flushed and sometimes swollen, violent vomiting and purging (frequently of bloody matters) soon come on, the vomiting being increased by every thing taken into the stomach; oftentimes there is irritation of the urinary passages, and sometimes even suppression of urine; the pulse is small, frequent, and contracted; the respiration difficult, the extremities cold. In some cases salivation is produced: this seldom comes on during the first 24 hours; and in those instances in which it does occur, is seldom delayed beyond the fourth day. Towards the termination of the case, some indications of disorder of the cerebro-spinal system come on, such as slight drowsiness or stupor, or even convulsions and twitchings of the muscles, and sometimes even violent convulsions; in some cases paraplegia. These symptoms terminate in death.

Post-mortem examination discovers inflammation, and its consequences of the gastro-intestinal membrane.

Theory of the Action of Mercury.—There are many dispute points connected with the action of mercurials, which it will be convenient to examine under this head.

1. Absorption of mercury.—By the external or internal use of mercury, this metal becomes absorbed (in what state has not been ascertained), and is subsequently either deposited in some of the solids of the body, or thrown out of the system by some of the excretories.

The accuracy of this statement is proved by the following facts:—

(a.) Mercury has been detected in the blood by Zeller, Buchner Schubarth (quoted by Dr. Christison, On Poisons, 3rd ed. p. 366), Colson (Arch. Gén. xii. 68), and Dieterich (op. cit.). It appears to be in such intimate combination with this vital fluid that it cannot be recognised by the ordinary tests. Destructive distillation is in most cases necessary for its detection.

(b.) Mercury has been found in the secretions, viz. in the perspiration, the saliva, the gastro-intestinal secretion, the bile, the urine, and the fluids of ulcers (Christison, Colson, and Dieterich, op. cit.). The blackening of the skin, mentioned both by Harrold (Meckel's Archiv. iii. 532) and Rigby (Lond. Med. Rep. April 1837), as having occurred in consequence of the use of mercury subsequent to the employment of sulphur, establishes the existence of mercury in the cutaneous transpiration. The sulphur and the mercury were thrown out of the system by the skin, and immediately they were out of the sphere of the vital powers, they entered into union and formed the black sulphuret of mercury, which was deposited on the integument in a pulvcrnt form.

(c.) Mercury has been found in the regurgitation state in the organic solids of the body, viz. in the bones, brain, synovial capsules, the pleura, the humour of the eye, the cellular tissue, the lungs, etc. (Christison, op. cit.; Wibmer Wirkung d. Arzneim. iii. 85; Colson and Dieterich, op. cit.) In what part of the system reduction is effected, has not been made out.

2. The constitutional effects of mercury are consequences of its absorption. For, in the first place, mercurials affect the general system to
Whatever part of the body they be applied, whether to the mucous membranes, the cutaneous system, or the cellular tissue, or injected into veins. Secondly, the action of mercurials on the system is assisted by use of bloodletting and emetics;—agents which promote absorption. Usually, when mercurials are administered by the stomach, and exciting, they rarely affect the general system, apparently in consequence the function of absorption being suspended.

1. After absorption, mercury effects changes in the qualities of the body, and in the action of the whole organism, but especially the apparatus of organic life.—Soon after salivation has been established, the body exhibits an inflammatory crust. At a later period its colour opens, and its coagulability is diminished: the proportion of clot, and before of fibrin, to serum becomes smaller. "The formation of albumen and mucus," says Dieterich (op. cit. 80), "sinks to that of serum; whole organic formation of the patient is less consistent and cohese." The same authority also tells us, that under the influence of mercury the electrical condition of the blood changes from the negative (alkaline) state to that of positive. The evacuations from all the secreting and exhaling organs, especially from the mucous follicles and salivary glands, is much increased. The secretion of bile is also promoted. Dr. Alison Philip (On the Influence of Minute Doses of Mercury, p. 14) says, "mercury has a specific operation on the liver,—a power not merely exciting its functions, but of correcting the various derangements of that action in a way which it does not possess with respect to any other organ, which no other medicine possesses with respect to the liver." I confess I am not acquainted with any facts warranting this assertion. The purgative effects of mercury arise partly from the increased secretion of bile, partly from the stimulus given to the mucous lining of the alimentary canal; more particularly to its follicular apparatus. The nervous system bears also to be specifically affected by mercurials. This is to be inferred partly from the effects produced in those who are subjected to the influence of this metal, such as the shaking palsy, &c. and partly from the effects of the soluble salts, when given in enormous doses. The heart and lungs are, in some cases, remarkably affected. This was particularly observed by Sir Benjamin Brodie (Phil. Trans. for 1812) in his experiments on animals with corrosive sublimate; as also by Smith, Orfila, and Gaspard. The affection of the urinary organs in poisoning by corrosive sublimate is also not to be forgotten.

The nature of the influence exercised by mercury over the organism has been a fertile source of discussion. One class of writers has regarded it as mechanical, a second as chemical, a third as dynamical.

a. Mechanical hypothesis.—Astruc (De Morb. Ven. ii. 149) and Barry (ed. Trans. i. 25) fancied that mercury acted by its weight, its divisibility, and its mobility; and thus getting into the blood separated its biles, rendered it more fluid and fit for secretion, made the lymph merier, and overcame any existing obstructions.

b. Chemical hypotheses.—Some have advocated the chemical operation of mercurials, and have endeavoured to explain their curative version the venereal disease by reference to their chemical properties, without success. Thus Mitić, Pressavin (quoted by Richter, Ausführ. Praxis, iv. 305), and Swediaur (Prac. Observ. on Venereal Complaints), named that mercury acted chemically on the syphilitic poison, as acids
and alkalies do on each other; while Girtanner (Abhandl. ü. d. Vener. Krankh.) supposed that the efficacy of mercurials depended on the oxygen they contain. To both hypotheses the same objection applies: if they were true, the larger the quantity of mercury used, the more effectually would the venereal disease be cured. Now this is not found to be the case. Dr. Cullen (Treat. of the Mat. Med. ii. 446) endeavoured to account for the action of mercury on the salivary glands, in preference to other organs, by assuming that it has a particular disposition to unite with ammoniacal salts, with which it passes off by the various excretions; and as the saliva was supposed to contain more of these salts than other secretions, he thus accounted for the larger quantity of mercury which passed off by these glands, and which being in this way applied to the excretories, occasioned salivation. But the whole hypothesis falls to the ground, when it is known that mercury has no "particular disposition" to unite with the ammoniacal salts; and that, even if it had, other secretions are as abundantly supplied with these salts as the saliva. Dr. John Murray substituted another hypothesis, but equally objectionable: —mercury, says he, cannot pass off by the urine, because of the phosphoric acid contained in this fluid, and which would form with the mercury, an insoluble compound. It must, therefore, be thrown out of the system by other secretions, particularly by the saliva, which facilitates this transmission by the affinity which the muriatic acid, the soda, and the ammonia of the secretion, have for the oxide of mercury, and by which a compound soluble in water is formed. The answer to this hypothesis is, that mercury is thrown out of the system by the urine, and probably in larger quantity than by the saliva; secondly, the saliva also contains phosphatic salts, according to Tiedemann and Gmelin.

(c.) Dynamical hypotheses.—Some writers have principally directed their attention to the quality of the effects induced by mercury, and have termed this mineral stimulant, sedative, both stimulant and sedative, tonic or alterative. Those who assume mercury to be a stimulant or excitant are not agreed as to whether particular parts or the whole system are stimulated, and, if particular parts, what these are. Thus Hecker fixes on the lymphatic system, Schöne on the arterial capillary system, Reil on the nerves (Richter, op. cit. v. 306). The simple answer to all of them is, that other stimulants are not capable of producing the same effects on the constitution as mercury; nay, are frequently hurtful in the very cases in which this metal is beneficial.

On the other hand, Conradi, Bertele, and Horn (quoted by Richter, op. cit. v. 307), considered it to be a weakening agent, or sedative. Hence those who adopt this hypothesis must assume that the diseases in which mercury is beneficial are of a phlogistic or hypersthenic character; and that syphilis, therefore, is of this kind,—an explanation not at all satisfactory, nor consistent with facts. Of late years, the sedative operation of some of the mercurial preparations (calomel and mercurial ointment) has been assumed (particularly by our countrymen practising in the East), from the circumstance that these agents allay vomiting and diarrhœa in yellow fever, cholera, and other dangerous diseases. But even admitting that mercurials do produce these effects, this is hardly a sufficient ground for denominating them sedatives.

Some think that mercurials, in small or moderate doses, are stimulants, but in excessive doses, sedatives; and that this sedative operation is
common to all substances when employed in large quantities. This is the opinion of Dr. Wilson Philip (op. cit.)

Dr. Murray (Syst. of Mat. Med.) calls mercury a tonic; Vogt (Pharmac.) terms it an alterative resolvent; Sundelin (Heilmittellehre) sees it among the resolvent alteratives, under the designation of liqueient (verflüssigende). Mr. Hunter (Treatise on the Venereal Disease) counts for its beneficial effects in syphilis, by saying it produces an alteration of a different kind from that caused by the venereal disease, and it counteracts the latter by destroying the diseased action of the agent.

Uses. 1. Of Metallic Mercury.—Liquid mercury has been used as a chemical agent, to dissolve silver coin which may have been accidentally swallowed; secondly, as a mechanical agent, to remove obstructions of the bowels; for example, intus-susception, or intestinal intussusception. But neither theory nor experience seem favourable to its use; for in the greater number of cases the intus-susception is progressive—that is, the superior portion of the gut is insinuated into the lower part, and, therefore, the pressure of the metal on the sides of the intestine cannot give relief; and even in cases of retrograde intus-susception, that is where the lower portion of the bowels passes into the upper, mercury, instead of pressing the intus-suspected portion back, might in further on, by getting into the angle of reflection between the lining and inverted gut (Hunter, Trans. of a Society for the Improvement of Med. and Chir. Knowledge, i. 103). Lastly, water, which had been boiled with mercury (aqua mercurialis cocta), was at one time used as an anthelmintic; but if the metal be pure, the water takes up no appreciable quantity of it. Moreover, it would appear that mercury has particular anthelmintic powers; for persons who were salivated have been freed from their worms, and Scopoli very frequently found natives in the workers of the quicksilver mines of Idria (Bremser, les Vers. Intest. 428).

Administration.—When taken internally it has been administered in various doses, from an ounce to a pound or more.

Of the Preparations of Mercury.—As errhines or aperients, mercurials are never resorted to now, though formerly the sublimate was used for these purposes.

As alteratives, they are given in small doses in various chronic cases; such, for example, as dyspepsia, gout, chronic skin diseases, fura, &c. Calomel is said to be less beneficial as an alterative than blue pill on account of its more irritating action on the bowels. The hydra-

mus cum creta is an excellent alterative, especially for children.

Certain preparations of mercury (as blue pill, calomel, and the hydra-

mus cum creta) are employed as purgatives. They promote secretion from the mucous follicles of the intestines, from the liver, and the biliary areas. They are rarely, however, used alone; being, in general, or combined with or followed by other cathartics (as jalap, senna, cynthia, or the saline purgatives). Thus it is a common practice to give a blue or calomel pill at night, and an aperient draught the following morning, the object being to allow the pill to remain as long as possible in the bowels, in order that it may the more effectively act on the liver. Mercurial purgatives are administered for various purposes, sometimes as anthelmintics, sometimes to assist in evacuating the con-

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tents of the alimentary canal; but more commonly with the view of promoting the secretions, particularly of the liver, or of producing counter-irritation, and thereby to relieve affections of other organs, as the skin or head.

The great value of mercurials is as sialagogues. Formerly it was supposed, that the beneficial effects of mercury were proportionate to the degree of ptalism, and thus to eradicate particular affections it was thought necessary to cause the evacuation of a given quantity of saliva. "I have heard," says Dr. Wilson Philip (op. cit. p. 19), the late Dr. Monro, of Edinburgh, state the quantity of saliva which must be discharged daily, to eradicate particular affections." Modern experience has proved the incorrectness of this notion; and we now rarely find it necessary to excite a high degree of salivation; indeed, frequently it would be prejudicial, but we sometimes find it requisite to keep up this effect for several weeks, particularly in diseases of a chronic character.

Production of sore mouth and salivation.—One of the most efficacious methods of putting the system under the influence of mercury is friction with the unguentum hydrargyri; but the troublesome and unpleasant nature of the process is a strong objection to it in practice, more especially in venereal diseases, in which patients usually desire secrecy. Full directions for its employment will be given hereafter (vide Ung. Hydrargyri). In the year 1779, Mr. Clare (Essay on the Cure of Abscesses by Caustic, also a New Method of Introducing Mercury into the Circulation, 1779) proposed a new method of causing salivation by friction, and which consists in rubbing two or three grains of calomel, or of the protoxide of mercury, on the inner surface of the cheeks and gums. It is said that the metal quickly becomes absorbed, and causes salivation and if care be taken not to swallow the saliva, diarrhoea does not occur. Notwithstanding that Hunter, Cruikshank, and others, have tried this plan, and reported favourably of it, and that it is free from the objections made to the use of mercurial ointment, it has never been a popular remedy. Fumigation, as a means of affecting the general system, is an old method of treating venereal diseases. Turner (On the Venereal Disease) employed for this purpose cinnabar; Lalouette (Nouv. Method. d' traiter les Malad. Vénér. 1776) calomel; and the late Mr. Abernethy (Surgical and Phys. Essays) the protoxide. Mr. Colles (op. cit. p. 58) has frequently seen fumigation fail in exciting salivation. He says an easy mode of fumigating any part is by using mercurial candles (composed of cinnabar or oxide of mercury mixed with melted wax, with a wick, and burnt under a curved glass funnel). Banmé used mercurial pediluvia to excite salivation, composed of half a grain of corrosive sublimate dissolved in a pint of distilled water; and in a solution of this strength the patient immersed his feet for the space of two hours; several objections, however, exist to the practice, which has been rarely followed. Upon the whole, the most convenient method of producing salivation is by the internal use of mercurials, particularly of those preparations which are mild in their local action, as blue pill, calomel, and the hydrargyrum cum creta.

Treatment before and during salivation.—Formerly the use of mercurials was preceded by antiphlogistic measures, such as blood-letting, purging, warm bathing, and low diet, but they are now rarely resorted to, though useful, by facilitating absorption. Mr. Colles (Practico
observations on the Venereal Disease, p. 28) thinks that these preparatory
cures have been improperly omitted, and that the want of them
is, of late years, contributed to bring this valuable remedy into much
repute—in which opinion I am disposed to join him. Occasionally
a difficulty is experienced in affecting the mouth, a circumstance
which may arise from the irritable condition of the bowels; and when
this is the case, inunction should be resorted to, or opium or vegetable
stringents conjoined. Sometimes, however, the system appears insus-
ceptible to the influence of mercury, and this may arise from idiosyncrasy,
from the presence of some disease, particularly fever. Emetics and
food-letting are useful in these cases, as they promote absorption; and
the influence of the former depends on the state of nausea produced,
eter emetic will be the best vomit, since it is the most powerful nau-
tant. Varying the mode of administering the mercury will also some-
times facilitate its operation on the system: thus, if it have been employed
internally, inunction should be tried, and vice versa.

During the time that the patient's mouth is sore, he should, if possible,
confine himself to the house, use warm clothing, avoid exposure to cold,
ake light but nourishing food, and regulate the state of his stomach and
wells. Mr. Hunter thought that during a mercurial course the manner
of living need not be altered: but Mr. Colles (op. cit. p. 34) has
properly, I think, objected to this. If the discharge become excess-
ve, or ulceration of the gums take place, the further use of mer-
cury is of course to be stopped; and, in order to moderate the effect
already produced, the patient should be freely exposed to a cool but dry
air, use purgatives and opium, and wash his mouth with some astringent
and stimulating liquid. I have generally employed, as a gargle, a solu-
tion of the chloride of soda or of lime; but in the absence of these, a
solution of alum, or of sulphate of copper, may be used. With regard
to internal remedies, I have no confidence in any as having a specific
power of stopping salivation, though iodine, sulphur, nitre, and other
substances, have been strongly recommended. Sometimes sulphate of
linia is administered with advantage.

Accidents during salivation. Occasionally, during salivation, certain
incidents result from mercury, which are in no way necessary or useful in a
therapeutical point of view: on the contrary, some of them are highly
judicial. Thus, sometimes, excessive salivation, with ulceration of the
mucous membranes, takes place, as already noticed: not infrequently gastro-intestinal
rivation (or actual inflammation) comes on, and which may require the
spension of the use of mercury, or its employment by way of inunc-
tion, or its combination with opium or vegetable astringents. I have
readily noticed fever, eczema mercuriale, mercurial erythysm of Pearson,
and other occasional effects. In feeble and irritable habits, mercury
sometimes disposes sores to slough. Occasionally a kind of metastasis of
the mercurial irritation is observed: thus, swallowing a large quantity of
cold water, or exposing the body to cold and moisture, has caused a tem-
porary cessation of salivation, attended with violent pains or convulsions,
great irritability of stomach.

Curative action of salivation. Though no surgeon ascribes the cura-
tive action of mercury to the salivation, yet, without this effect, the
rative influence is not usually observed. Hence, though the one can't
be considered to stand to the other in the relation of cause and effect,
yet the two are usually contemporaneous: so that when we fail to induce some affection of the mouth, we do not observe the beneficial effects of mercury. (On this subject consult Colles, op. cit. p. 31).

Diseases for which salivation is employed.—Having offered these general remarks on salivation as a remedial agent, I proceed to notice its use in particular diseases.

(a.) Fever.—It has been said that salivation diminishes the susceptibility to the contagion of fever, whether common or specific; but that it is not an absolute preventive is shown by the fact, that patients under the full influence of mercury have caught fever and died of it, as will be found noticed by my friend, Dr. Clutterbuck, in his Inquiry into the Seat and Nature of Fever. I have several times used mercurials as sialogogues in fever; I believe, for the most part, with advantage. I have only used them when there was some marked local determination or inflammatory condition. I have seen three fatal cases of fever in which mercurials were used profusely, without having any effect on the mouth; but in other instances, in which the mouth became affected, recovery took place. My experience, therefore, agrees with that of Dr. Copland (Dict. of Pract. Med. i. 929), namely, that death, after salivation has been established, is very rare. Whether the recovery was the consequence of the mercurial action, or the salivation the result of the mitigation of the disorder, as Dr. Bancroft (On Yellow Fever) and Dr. Graves (Lond. Med. Gaz. xx. 147) assert, cannot be positively proved, though I think the first more probable. Dr. Graves (op. cit.) declares the use of mercury in fever to be both injudicious and unnecessary, unless inflammation of some organ be set up. In this opinion I cannot agree with him. Dr. Macartney (Treatise on Inflammation, p. 162), on the other hand, says, “In no single instance have I known it [mercury] fail in arresting the progress of the disease, provided the fever be not combined with visceral affections, or characterized from the beginning with unusual prostration of strength.” The great indisposition of the system, in fever, to take on the mercurial action, is frequently a most annoying circumstance. It may sometimes be overcome by the employment of mercurials both internally and externally. Mr. Lempriere (Pract. Observ. on Diseases of the Army of Jamaica), who practised in Jamaica, finding that calomel was often exhibited in immense quantities, without exciting any apparent action, was induced to employ corrosive sublimate in doses of the eighth part of a grain, with the addition of ten drops of laudanum, and this quantity was repeated every hour until some affection of the mouth was observed, or until the more alarming symptoms had considerably abated.

The beneficial influence of mercurials has been more particularly experienced in the fevers of warm climates, especially those of the East Indies (Johnson, On Diseases of Tropical Climates, pp. 32, 96, 97, 122, &c. &c. 3d. ed.; Annesley, On the Diseases of India, p. 391, 2d. ed.) It has been said by several writers (Johnson, op. cit. p. 37; Bancroft, On Yellow Fever; Musgrave, Edinb. Med. & Surx. Journ. xxviii. 40), that in the yellow fever of the West Indies its beneficial effects are not equally evident.

(b.) Inflammation.—Of late years various forms of inflammation have been most successfully combated by the use of mercury. Hence this mineral is termed an antiphlogistic. We are principally indebted to Dr.
MERCURY OR QUICKSILVER.

Hamilton (Duncan's Med. Comm. vol. ix.), Dr. Yeats (Duncan's Ann. of Med. vol. vii.), Dr. Wright (Med. Facts & Observ. vol. viii.), and Rambach Dissert. Usus Mercurii in Morb. Inflamm. 1794) for its introduction into this form of disease. Its influence is that of a profoundly acting irritative (vide p. 10). Its curative power is not satisfactorily accounted for by the equalization of the circulation, the augmentation of the secretions, or the increased activity of the absorbents caused by mercury.

Mercury is not equally serviceable in all inflammations, but it is exceedingly difficult to generalize; that is, to point out in what circumstances those inflammations agree which are benefited by it. It appears, however, that the nature of the tissue, the structure of the organ affected, and the quality or kind of inflammation, are points of considerable importance as affecting its use.

Thus it appears that inflammations of membranous tissues are those principally benefited by a mercurial plan of treatment; and more especially those in which there is a tendency to the exudation of coagulable lymph or of serous fluid—as meningitis, pleuritis, pericarditis, and peritonitis (particularly of puerperal women). In inflammation of the lining membrane of the air-tube, but more especially in croup, or, as it is sometimes termed, plastic inflammation of the larynx, mercury is one of our most valuable remedies; and as this disease is one which terminates rapidly, no time should be lost in getting a sufficient quantity of mercury into the system. Calomel is usually employed; but when the bowels are very irritable, the hydrargyrum cum cretâ, or even mercurial unction, may be resorted to. In inflammation of the tunics of the eye, particularly iritis, mercury (next to blood-letting) is the only remedy on which much confidence can be placed; and we use it not merely with a view of putting a stop to the inflammatory action, but also in order to cause the absorption of the effused lymph (Lawrence, Lectures on Diseases of the Eye, in Lancet, vol. x. p. 198; Mackenzie, On Diseases of the Eye, 3d ed. pp. 389, 394, 503). In inflammation of the synovial membranes, mercury has been employed, and in some cases with manifest advantage.

Dysentery, mercury has been extensively used, especially in warm climates. By some, calomel has been employed merely as a purgative (Jackson, Ballinghall, Bampfield, and Annesley); by others, to produce sialogogue effects (Johnson and Cunningham).

The structure of the organ influences the effect of mercury: at least is well known that this mineral is more beneficial in inflammation of certain organs (especially those of a glandular structure, as the liver) than of others; and we refer it to some peculiarity in the structure of the part affected. In hepatitis of either temperate or tropical climates (particularly of the latter), mercury is advantageously employed (Sir James Grigor, Medical Sketches; Johnson, On Tropical Climates; Annesley, on Diseases of India). Blood-letting, however, should be premised, particularly in the disease as usually met with in this country. In pneumonia, more especially when hepatization has taken place, the best effects have sometimes resulted from its use; of course after the employment of blood-letting. When hepatization has taken place, Dr. Davies (Ref. on the Diseases of the Lungs, &c. p. 191) recommends the use of the pill and opium. In inflammation of the substance of the brain, so, mercury may be advantageously resorted to, after the usual pletives.
The nature or quality of the inflammation also influences the effects, and thereby the uses, of mercury. Thus, in syphilitic inflammation, mercurials are of the greatest utility; less so in rheumatic inflammation; still less in scrofulous; and most decidedly objectionable in cancerous or scrofulous diseases. The treatment of rheumatism by calomel and opium was proposed by Dr. Hamilton (op. cit.), and has found many supporters (vide Dr. Hope, Lond. Med. Gaz. xix. 815); and, undoubtedly, when the febrile action does not run too high, or when the pericardium becomes affected, calomel and opium, preceded by blood-letting, will be found serviceable. It appears to be best adapted to the fibrous or diffuse form of the disease, and to fail in the synovial (Dr. Macleod, Lond. Med. Gaz. xxi. 361). The scrofulous habit is, for the most part, unfavourable to the use of mercury given as a sialogogue, but there are cases in which it is not only admissible but serviceable—as scrofulous ophthalmia, when of an acute kind. In all maladies of a malignant character (as cancer, fungoid disease, &c.) mercurials are highly objectionable.

(c.) Venereal diseases.—It was formerly the opinion of surgeons that the symptoms of venereal diseases were progressive, and never disappeared until mercury was administered; but it has, of late years, been clearly proved that this notion is erroneous: and we are indebted to some of our army surgeons—namely, to Messrs. Ferguson, Rose, Guthrie, (Med. Chirurg. Trans. vols. iv. and viii.), Hennen (Military Surgery), and Bacot (On Syphilis, 1821), and to Dr. Thomson (Ed. Med. and Surg. Journ. xiv.)—for showing that the venereal disease, in all its forms, may be cured without an atom of mercury. Moreover, it is fully established by the experience of almost every surgeon, that while in some instances mercury exercises a beneficial influence hardly to be observed with respect to any other disease or any other remedy, yet, that in some cases it acts most injuriously; and it is generally supposed that many of the bad venereal cases formerly met with, arose, in great part, from the improper use of mercury. It is a point, therefore, of considerable importance, to determine what cases are best adapted for a mercurial, and what for a non-mercurial, method of treatment; for in admitting the possibility of a cure without this agent, it is not to be inferred that the method is either eligible or expedient; nay, the very persons who have proved this possibility, admit that in some cases this mineral, given so as to excite moderate salivation, is advisable. One fact is, I think, now tolerably well established—viz. that the cure of venereal diseases without the aid of mercury is much slower and less secure against relapses than by a mercurial treatment (vide Colles, Pract. Observ. on the Vener. Disease, p. 318). It is not easy to lay down rules to guide us in the selection of the one or the other of these methods of treatment. Mr. Carmichael (On Venereal Diseases, 2d ed. 1825) relies principally on the eruption, and, next to this, on the appearance of the primary ulcer; and of the four forms of the venereal disease which he has described, namely, the papular, the pustular, the phagedenic, and the scaly, full courses of mercury are required, he says, in one only—namely, the scaly; in which the primary sore is the Hunterian chancre or callous ulcer, and the eruption partakes of the characters of lepra or psoriasis. But it has been satisfactorily proved by experiments made in the military hospitals, that even this scaly form of the disease may get well without mercury; and, on the other hand, in the pustular and papular forms, mercury is often a
The circumstances which deserve attention, as affecting the use of mercury, are numerous. The following are the principal:

1. Scrofula.—Some of the worst and most intractable forms of the scrofulous disease occur in scrofulous subjects; and in such, mercury is in general prejudicial. I have seen numerous instances of its injurious effects. One case which fell under my notice was that of a medical student, who, after three years' suffering, died; having been made much worse on two occasions by what I conceived to be the improper use of mercury, once by his own act, and a second time by the advice of the physician of his family. Mr. Colles (op. cit. p. 236), however, denies the injurious influence of mercury in scrofula, and advises its use for the cure of syphilis in scrofulous subjects; but he admits that the profession generally entertain a contrary opinion.

2. Condition of the primary ulcer.—Another point deserving attention is the condition of the primary sore: if it be much inflamed, or of an irritable nature—if it be of the kind called phagedenic, or at all disposed to slough—mercury must be most carefully avoided, as it increases the disposition to sloughing. In one case that fell under my notice, a gentleman lost his penis by the improper use of mercury, under the circumstances just mentioned.

3. Extreme debility with hectic fever.—This condition is usually believed to contra-indicate the employment of mercury. But Mr. Colles (op. cit. p. 206) asserts, "that a patient affected with secondary symptoms, even though extremely attenuated, and, as it were, melting away under the effects of hectic, can with perfect safety and advantage at once commence a course of mercury; by which not only shall his venereal symptoms be removed, but at the same time his general health be re-established."

(d) Cholera.—Writers on the spasmodic cholera, both of this country and of India, speak for the most part favourably of the effects of mercury, especially in the form of calomel. I may refer to the works of Drs. Johnson, Venables, and Hamett, and of Messrs. Annesley, Orton, and Hennen, in proof. I have met with no writers who attribute ill effects to mercury in this malady. Unfortunately those who advocate its use are not agreed as to the quantity, or frequency of repetition, or to advising it as a purgative; some recommend it as a sedative, in combination with opium; others, lastly, using it as a stimulant. It is deserving of especial notice, that when salivation takes place, the patient in general recovers. Dr. Griffin (Lond. Med. Gaz. xxi. 582), however, has shown that this is not invariably the case. (For further information on the use of mercurials in cholera, vide Hydrargyri Floridum).

(e) Dropsy.—In this disease, mercurials may do either good or harm. When the dropsical effusion depends on inflammation, they may be played with the best effects, as when hydrocephalus arises from meningitis, or hydrothorax from pleurisy. When ascites is occasioned by an enlarged liver, which compresses the vena portae, and thereby gives rise
to effusion, mercurials are sometimes beneficial. On the contrary, when dropsy occurs in old subjects, and when it depends on, or is accompanied by, general debility, salivation is almost always hurtful. Moreover, when the effusion arises from mechanical causes not removable by mercury, as obliteration of any of the venous trunks, or pressure of malignant tumors, salivation is injurious. Occasionally dropsical effusion takes place without any appreciable cause, and then, of course, if mercury be employed, it must be in part on speculation. In such cases calomel is not unfrequently employed in combination with squills or foxglove.

(f.) In chronic diseases of the visceara, especially those arising from or connected with inflammation, mercury is frequently serviceable. Thus, in enlargement or induration of the liver, in hepatization of the lungs, &c. In those diseases commonly termed malignant, as cancer and fungus haematodes, and also in diseases of a non-malignant character, but occurring in debilitated subjects, mercurials, given so as to excite salivation, are objectionable.

(g.) In chronic diseases of the nervous system.—Mercury has been recommended in paralysis, and on some occasions has proved exceedingly efficacious. I have seen hemiplegia, with impaired vision and hearing, headache, and cramps of the extremities, recover under the use of mercury, after blood-letting, purgatives, &c. had failed. The patient (a young man) was kept under the influence of the medicine for two months. Mr. Colles (op. cit. p. 327) has likewise found it most efficacious in paralysis. In tetanus, mania, epilepsy, hysteria, tic douloureux, and other affections of the nervous system, mercury has been used with occasional benefit.

The foregoing are some of the more important diseases against which mercurials have been successfully administered as sialogogues.

Hydrargyrum cum Cre'tâ.—Mercury with Chalk.

History.—This compound (called also mercurius alcalisatus, or æthiops absorbens) is first mentioned, I believe, by Burton, in 1738.

Preparation.—It is prepared by rubbing three ounces of mercury with five ounces of chalk, until globules are no longer visible. On account of the tediousness of the process, the friction is usually effected by steam.

If this powder be digested in acetic acid, the lime of the chalk is dissolved, and the carbonic acid escapes; but the greater part, if not the whole of the mercury, is insoluble in the acid, and hence is not the protoxide. If examined by a lens, the residuum is found to consist of minute separate globules, which readily whiten silver and gold, showing they are in the metallic state. Hence it is probable that the quicksilver is, for the most part, mechanically divided only, but a small portion may perhaps be oxidized.

Properties and Characteristics.—It is a greyish powder, which effervesces on the addition of acetic acid, yielding a solution of lime which may be distinguished by the tests for the calcareous salts already mentioned. By digestion in nitric acid, we obtain a solution known to contain mercury by the characters already detailed for the mercurial preparations generally. By heat the mercury is volatilized, leaving the chalk.

Composition.—It consists of mercury and chalk, with perhaps a little
Physiological Effects.—It is an exceedingly mild but valuable mercurial. In full doses it acts as a gentle laxative, promoting the secretion of bile and intestinal mucus, but sometimes creating a little weakness. The chalk renders it antacid. By repeated use it occasions the constitutional effects of mercury already described.

Uses.—It is a valuable remedy in *syphilis infantum*. It is frequently employed to promote and improve the secretions of the liver, pancreas, and bowels, in various disordered conditions of the digestive organs, accompanied by clay-coloured stools or purging. In strumous affections of children (especially enlarged mesenteric glands), and other chronic maladies, it is administered with great advantage as an expectorant.

Administration.—To adults it is given in doses of from five grains to scruple, or half a drachm. For children the dose is two or three grains. Rhubarb, carbonate of soda, or, in some cases, Dover’s powder, may be conjoined with it.

*Hydrargyrum cum Magnesia.—Mercury with Magnesia.*

Under this name there is a compound in the Dublin Pharmacopoeia, prepared by rubbing two parts of mercury with two parts of manna until the globules disappear, and then washing out the manna with water, and adding eight parts of subcarbonate of magnesia. Its effects and uses are analogous to the preparation just described.

*Pilulae Hydrargyri.—Pills of Mercury.*

History.—The oldest formula for mercurial pills is that of Barbarossa (one time admiral of the Turkish fleet, and afterwards governor or king of Algiers), and which was communicated by him to Francis the first, king of Franconia, who made it public. The common name for this preparation is blue pill, or pilulae ceruleae.

Preparation.—In the London Pharmacopoeia it is ordered to be prepared by rubbing two drachms of purified mercury with three drachms of confection of roses, until globules are no longer visible, and then adding a drachm of powdered liquorice-root. In the Dublin Pharmacopoeia extract of liquorice is substituted for the root. In the Edinburgh pharmacopoeia one part of mercury, one of confection of roses, and two-thirds of starch, are employed. The friction is usually effected by steam power. After triturating the metal is reduced to a finely-divided state, and becomes ultimately mixed with the confection and liquorice powder.

Properties.—It is a soft mass, of a convenient consistence for making into pills, and has a dark blue colour. When rubbed on paper, or glass, it does not present no globules; but applied to gold it communicates a greyish stain.

Composition.—Three grains of this pill contain one grain of mercury. Impurity.—If any sulphuric acid should have been added to the confection to brighten its colour, some sub sulphate of mercury will be formed—a compound which possesses very energetic properties.
Physiological Effects.—In full doses (as fifteen grains) it frequently acts as a purgative. In small doses it is alterative, and, by repetition, produces the before-mentioned constitutional effects of mercurials.

Uses.—The practice of giving a blue pill at night, and a second draught the following morning, has become somewhat popular, in consequence of its being recommended by the late Mr. Abernethy, in various disorders of the chylopoietic viscera. As an alterative, in doses of two or three grains, blue pill is frequently resorted to. Lastly, it is one of the best internal agents for exciting salivation, in the various diseases for which mercury is adapted.

Administration.—The usual mode of exhibiting it is in the form of pill, in the doses already mentioned; but it may also be administered when suspended in a thick mucilaginous liquid. If the object be to excite salivation, we may give five grains in the morning, and from five to ten in the evening; and to prevent purging, opium may be conjoined.

Unguentum Hydrargyri.—Ointment of Mercury.

History.—Mercurial ointment was known to, and employed by, the ancient Arabian physicians—for example, Abhengeufith, Rhazes, and Avicenna: so that it has been in use certainly 1000 years. However, Gilbertus Anglicus, who lived about the commencement of the thirteenth century, was the first who gave a detailed account of the method of extinguishing mercury by fatty matters. Besides its more common appellation of mercurial ointment, it was formerly termed blue or Neapolitan ointment.

Preparation.—In the London, Dublin, Edinburgh, and United States Pharmacopoeias, the unguentum hydrargyri fortius is prepared by rubbing two pounds of mercury with an ounce of suet and twenty-three ounces of lard, until globules are no longer visible. To promote the extinction of the mercury, the metal should be previously triturated with some old mercurial ointment. Rancid lard also assists the extinction of the globules.

Some assert that the mercury is in a finely-divided metallic state, though, if well prepared, there are no appearances of globules when the ointment is examined by a lens. In favour of this view Guibourt (Pharm. Raisonnee, ii. 140) states, that by digesting ether on mercurial ointment, the fatty matter may be dissolved and liquid mercury obtained in equal weight to that used in making the ointment. Now it is unlikely, if the mercury had been previously oxidized, that the ether could deoxidize it; and therefore, this experiment (supposing the results to be those mentioned) appears almost decisive that the mercury is in the metallic state; but on repetition of the experiment, I have not obtained the results stated by M. Guibourt. Mr. Donovan, however, thinks that part of the mercury attracts oxygen, and that the oxide thus formed unites with the fatty matter. I have seen no satisfactory explanation of the efficacy of old mercurial ointment in extinguishing the mercury; Guibourt offers the following:—By trituration, both lard and mercury assume oppositely electrical states, the lard becoming negative, the mercury positive; these states, he supposes, determine a more intimate mixture of the particles, and a greater division of the mercury.

Now
acid lard and old mercurial ointment, having attracted oxygen from the
s, more readily take on the negative condition, and hence their efficacy
promoting the extinction of the mercurial globules. Guibourt also
asserts, that mortars of marble or wood are better adapted for making
his ointment than those of metal, on account of their power of eon-
ing electricity being less.

Properties.—It is an unctuous fatty body of a bluish grey colour,
and if properly prepared, gives no traces of globules when rubbed on
per, and examined by a microscope; but when rubbed on gold, it
takes it.

Composition.—This compound contains half its weight of mercury.

Physiological Effects.—Mercurial ointment possesses very little
power of irritating the parts to which it is applied; but when either
allowed or rubbed into the integuments, readily produces the constitu-
tional effects of mercury. Thus Cullerier says, that three or four pills,
containing each two grains of this ointment, and taken successively, have
en sufficed to excite violent salivation. He also tells us, that if the
beet be to produce ptyalism, in a very short space of time, we may
get it by giving half a drachm of the ointment in the space of twenty-
our hours.

When rubbed on the surface of the body, it produces the same con-
stitutional effects as the other preparations of mercury; but if the lard
rich it contains be not rancid, no obvious local effect is usually pro-
duced. Applied to ulcerated surfaces, mercurial ointment is a stimulant,
and in syphilitic sores is oftentimes a very useful and beneficial appli-
ation.

Uses.—It is rarely or never administered internally in this country,
but has been much used on the continent, and with great success.
Certainly well deserves a trial where the system appears insus-
litile to the influence of mercury; for Cullerier says, the difficulty
in him has been rather to check than to excite salivation by it.

Applied externally, it is employed either as a local or constitutional
medic. Thus as a local agent it is used as a dressing to syphilitic
les, or rubbed into tumors of various kinds (not those of a malignant
cure, as cancer and fungus hæmatodes), with the view of exciting the
action of the lymphatic vessels. Sometimes, also, it is employed to
spray parasitic animals on the skin. As a means of affecting the con-
titution we use mercurial inunctions in syphilis, in inflammatory dis-
es, and, in fact, in all the cases (already noticed) in which our object
is to set up the mercurial action in the system, more especially when the
stable condition of the digestive organs offers an objection to the
nal employment of mercurials. It may be laid down as a general
law, that mercury may be used with more safety by the skin than by the
mouth; but reasons of convenience, which I have already alluded to,
should lead us to its internal use.

Administration.—Internally, it is given in doses of from two to five
grs, made into pills, with either soap or some mild powder, as liquo-
. Externally, when the object is to excite very speedy salivation,
a drachm may be rubbed into the skin every hour, washing the part
in time, and varying the seat of application. If, however, it be
desirable or necessary to produce such a speedy effect, half a
drachm or a drachm, rubbed in night and morning, will be sufficient.
During the whole course of inunction the patient should wear the same drawers night and day.

When the friction is performed by a second person, the hand should be enveloped with soft oiled pig's bladder, turned inside out (Colles, op. cit. p. 42). In making use of mercurial frictions, it is to be recollected they ought not to be violent, but long continued, and had better be carried on near a fire, in order to promote the liquefaction and absorption of the ointment. In syphilis, and other diseases in which our sole object is the constitutional affection, it matters little to what part of the body the ointment is applied, provided the cuticle be thin (for this inorganized layer offers an impediment to absorption in proportion to its thickness). The internal parts of the thighs are usually, therefore, selected. However, in liver complaints, the inunctions are made in the region of the organ affected. The occasional use of the warm bath promotes absorption when the ointment is applied to the skin.

**Unguentum Hydrargyri Mitius** (Ph. Lond. & Dublin).—This is prepared by mixing a pound of strong mercurial ointment with two pounds of lard. It contains a sixth part of its weight of mercury. This preparation is applied as a dressing to ulcers and cutaneous diseases.

**Ceratum Hydrargyri Compositum** (Ph. Lond.: stronger ointment of mercury; soap cerate, ⅓ iv.; camphor, ⅜. M.)—Its uses are similar to those of the following preparation:

**Linimentum Hydrargyri Compositum** (Ph. Lond.: stronger ointment of mercury; lard, of each, ⅓ iv.; camphor, ⅜; rectified spirit, ⅓; solution of ammonia, ⅓ iv. M.)—It is used (by way of friction) in chronic tumors, chronic affections of the joints, &c., where the object is to excite the action of the lymphatic vessels. It is stated to cause salivation more readily than the common mercurial ointment, owing to the camphor and ammonia.

**Emplastrum Hydrargyri.—Plaster of Mercury.**

In the London Pharmacopoeia, this is ordered to be prepared by adding eight grains of sulphur to a fluidrachm of heated olive oil, stirring until they unite. Then rub the mercury with the oil until the globules are no longer visible, and add a pound of melted lead plaster. In this process the sulphur of the sulphurred oil forms with the mercury a sulphuret, while the remainder of the metal is mechanically divided. Each drachm of the plaster contains fifteen grains of mercury.

It is supposed to stimulate the lymphatic vessels of the parts to which it is applied, and is used as a discutient in glandular enlargements and other swellings, whether venereal or otherwise, and also to the region of the liver in hepatic complaints. Dr. Wilson Philip (op. cit.) has seen it induce salivation.

**Emplastrum Ammoniaci cum Hydrargyro** (Ph. Lond.)—This is prepared in a similar manner to the last preparation, except that the gum-resin ammoniacum is substituted for the lead plaster. The preparation of the Dublin Pharmacopoeia consists of ammoniacum, lb. j.; purified mercury, ½ j.; common turpentine, ½ j. M. It is a more powerful compound than the last, and is employed in the same cases, especially in venereal buboes.
**Hydrargyri Oxydum.—Oxide of Mercury.**

**History.**—The mode of preparing this compound was taught by Osset in 1797. This oxide is sometimes termed the protoxide, suboxide, ash, grey, or black oxide (hydrargyri oxydum cinereum, hydrargyri oxydum nigrum).

**Preparation.**—In the London Pharmacopoeia it is prepared by pouring one ounce of calomel to a gallon of lime water: then frequently take them, set by, and when the oxide has subsided, pour off the supernatant liquor, and wash the precipitate with distilled water: afterwards wrap it (wrapped in bulibulous paper) in the air.

In this process double decomposition takes place: chloride of calcium formed in solution, while oxide of mercury precipitates.

<table>
<thead>
<tr>
<th>Reagents.</th>
<th>Results.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlor. Merc. = 238 1 eq. Chlorine = 36 1 eq. Chloride Calcium = 56</td>
<td></td>
</tr>
<tr>
<td>Lime = 28 1 eq. Mercury = 202 1 eq. Calcium = 20 1 eq. Oxygen = 8 1 eq. Oxide of Mercury = 210</td>
<td></td>
</tr>
</tbody>
</table>

In the Edinburgh Pharmacopoeia one-fourth more lime-water is employed, and the mixture boiled for a quarter of an hour. In the Dublin Pharmacopoeia, one part of calomel and four of water of caustic potash is employed. In this case chloride of potassium is formed in solution.

**Properties.**—Pure oxide of mercury is black, or nearly so. The present preparation, however, is frequently greyish, owing to the presence of some undecomposed calomel. It is readily decomposed by light (especially by the solar rays), becomes olive coloured, and is resolved into metallic mercury and the binoxide. It is odourless, tasteless, insoluble in water and the alkalies, but soluble in nitric acid and acetic acid. By the action of hydrochloric acid it forms water and calomel. When heated it first decomposed, and then completely dissipated.

**Characteristics.**—Heated in a glass tube it evolves oxygen, while metallic globules are sublimed. Dissolved in nitric acid it forms a protomericurial salt, known by the before-mentioned characters for these substances.

**Composition.**—The composition of this oxide is as follows:

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>262</td>
<td>96-19</td>
<td>96-2</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>3-81</td>
<td>3-8</td>
</tr>
<tr>
<td>Oxide of Mercury</td>
<td>1</td>
<td>210</td>
<td>100-00</td>
<td>100-0</td>
</tr>
</tbody>
</table>

**Purity.**—Digested, for a short time, in dilute hydrochloric acid, the solution, when filtered, should form no precipitate with either potash or alate of ammonia. If any binoxide had been dissolved, the potash would throw it down as a reddish or yellowish hydrate. If any carbonate lime had been precipitated, the oxalate would recognise it.

**Physiological Effects.**—Pure oxide of mercury is one of the least irritating of the mercurial preparations, and, therefore, when swallowed, does not produce much disorder of the alimentary canal. In small doses acts as an alterative and purgative. When taken in repeated doses, constitutional effects are similar to those of other mercurials.

**Uses.**—Mr. Abernethy employed it as a fumigating agent. The following are his directions for using it:—Place the patient in a vapour
bath, in a complete suit of under garments, with a cloth around his chin. Two drachms of the oxide are then to be put on a heated iron within the machine in which the patient is sitting. After continuing in the bath for about fifteen or twenty minutes, the body is found to be covered with a whitish powder. The patient should be placed in bed, and lie in the same clothes till morning, and then go into a tepid bath. By this mode of proceeding, Mr. Abernethy says, he has known salivation induced in forty-eight hours.

Oxide of mercury is rarely employed as an internal remedy; indeed, its varying composition is a strong objection to its use. As an external application it has been used in the form of ointment, and also suspended in a weak solution of chloride of calcium, under the name of black-wash.

**Administration.**—For internal use the dose is from half a grain to two or three grains.

**Unguentum Hydrargyri Oxydi** (oxide of mercury, 1 part; lard, 3 parts: mix them thoroughly, Ph. Edinb.)—This is intended to be a substitute (of a fixed strength) for the common mercurial ointment. According to Mr. Donovan, this ointment should be kept at a temperature of 350° F., for the space of two hours, in order that the oxide and the fatty matter may enter into union. It is used as a substitute for mercurial ointment.

**Lotio Nigra** (black-wash; *aqua mercurialis nigra; aqua phageu-nica mitis*).—This is prepared by adding calomel to lime-water. The proportions of the ingredients may be varied, but in general one drachm of calomel is used to a pint of lime-water. Oxide of mercury precipitates, and chloride of calcium remains in solution. As the efficacy of the wash depends on the oxide, the bottle must be well shaken every time of using it. This compound is a favourite application to venereal sores of almost all kinds,—in most being serviceable, in few or none being hurtful.

*Hydrargyri Binox’ydum.—Binox’ide of Mercury.*

**History.**—This is the peroxide or red oxide of mercury of some writers. Geber (*Sum of Perfection*, book i. part iv. ch. 16) describes the method of making that variety of it which is prepared by calcination, and which was formerly called *red precipitate per se* (*mercurius precipitatus ruber per se*) or calcined mercury (*hydrargyrum calcinatum*). He calls it congealed mercury.

**Preparation.** (a.) *By precipitation.*—In the London Pharmacopoeia this compound is directed to be prepared by adding 28 fluidounces of solution of potash to four ounces of bichloride of mercury, dissolved in six pints (120 fluid ounces) of distilled water. The precipitated powder is to be washed with distilled water until the latter comes off tasteless, and is then to be dried.

In this process one equivalent or 274 parts of bichloride of mercury are decomposed by two equivalents or 96 parts of potash, and yield one equivalent or 218 parts of binoxide of mercury, and two equivalents or 152 parts of chloride of potassium.

<table>
<thead>
<tr>
<th>Reagents</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Bichlées Mercury</td>
<td>274 eq. Chloride</td>
</tr>
<tr>
<td>2 eq. Chloric</td>
<td>72</td>
</tr>
<tr>
<td>1 eq. Mercury</td>
<td>262</td>
</tr>
<tr>
<td>2 eq. Potash</td>
<td>96</td>
</tr>
<tr>
<td>2 eq. Potassium</td>
<td>80</td>
</tr>
<tr>
<td>2 eq. Oxygen</td>
<td>16</td>
</tr>
<tr>
<td>1 eq. Binoxide of Mercury</td>
<td>24</td>
</tr>
</tbody>
</table>
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BINOXIDE OF MERCURY.

4) By calcination.—In the Dublin Pharmacopoeia, hydrargyrum oxy-
rubrum is directed to be prepared by exposing mercury to a heat of
, in an open glass vessel, with a narrow mouth and broad bottom,
it is converted into red scales. The heat vapourizes the mercury,
which in this state attracts oxygen from the air, and forms this red or-
oxide. The long neck of the vessel prevents the escape of the vapours
newly-formed oxide.

The process is a very tedious one, occupying several weeks; so that
per's remark was correct, that "it is a most difficult and laborious
, even with the profoundness of clear-sighted industry." The appara-
s which Mr. Boyle contrived for the manufacture of it, was long
ed "Boyle's Hell," from a notion that the mercury was tortured in it.

PROPERTIES.—When prepared by precipitation it is in the form of an
large-red powder; but when made by calcination, occurs in small brilli-
and scales of a ruby red colour. Both varieties agree in the following
properties:—They are odourless, have an acid metallic taste, are inso-
ble in water, but soluble in both nitric and hydrochloric acids. They
are decomposed and reduced by heat and solar light: the precipitated
mercury is more readily acted on by solar light than the variety made by
calcination.

CHARACTERISTICS.—When heated in a glass tube by a spirit lamp, it
is decomposed into oxygen and mercury: the first may be recognised by
showing match, the second condenses in small globules. It dissolves
completely in hydrochloric acid: the solution contains bichloride of mer-
cury, which may be known by the tests hereafter to be mentioned for this
stance (vide HydrargyrI Bichloridum).

COMPOSITION.—The composition of this substance is as follows:—

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>92.66</td>
<td>92.68</td>
<td>92.75</td>
</tr>
<tr>
<td>Oxygen</td>
<td>2</td>
<td>16</td>
<td>7.34</td>
<td>7.32</td>
<td>7.25</td>
</tr>
</tbody>
</table>

Binoxide of Mercury | 1   | 218    | 100.00    | 100.00     | 100.00   |

Binoxide of mercury prepared by precipitation usually contains some
mercury, and be insoluble in water. Its solution in nitric acid should be un-
ited by nitrate of silver, by which the absence of any chloride is
stated. If an insufficient quantity of potash be employed in the prep-
ration of the precipitated variety, the product is brownish or brick-dust
and contains oxichloride of mercury. (composed, according to berain, of 1 eq. bichloride of mercury and 3 eqs. of binoxide: mas, Traité de Chimie, iii. 615).

PHYSIOLOGICAL EFFECTS.—Binoxide of mercury is a powerful irritant,
taken internally, even in small doses, readily excites vomiting and
purging; large doses would excite gastro-enteritis. Orfila (Toxicol.
) found that binoxide, obtained by precipitation from four grains of
chloride, killed a dog in eighteen minutes. The constitutional effects
this preparation are the same as those of mercurials generally.

USES.—Binoxide of mercury is rarely employed as a medicine. It
been applied as an escharotic, either in the form of powder or oint-
ment. Internally it was formerly exhibited to excite salivation in
venereal diseases, but is objectionable, especially where the bowels are
morbidly irritable. It is rarely or never used now.

In pharmacy it is employed in the preparation of bieyanide of mercury
(vide Hydrargyri Bicyanidum).

Administration.—The dose of it is from a quarter of a grain to a
grain, given in the form of pill, in combination with opium.

Lotio Flava: Lotio (seu aqua) phagedenica: yellow wash.—This
compound, which was formerly in frequent use, is prepared by adding
bichloride of mercury to lime-water. The proportions vary in different
formula. The quantity of bichloride should not, I think, exceed two
grains to an ounce of lime-water: the usual proportions are thirty grains
of bichloride to sixteen ounces of lime-water. The preparation, then,
consists of the yellow hydrated binoxide of mercury (which precipitates)
chloride of calcium, and caustic lime; the two latter being in solution.
But if the quantity of bichloride exceed $\frac{3}{2}$ grains to an ounce of lime-
water, the precipitate is brown or brick-dust coloured, and contains
oxichloride of mercury, while the clear liquor holds in solution some
hydrargyro-chloride of calcium; that is, a saline combination, in which
chloride of calcium is the base, and bichloride of mercury the acid
(Guibourt, Journ. Chim. Méd. iii. 377; also Pharm. Raisonnée, i. 563;
and Souberain, Nouv. Traité de Pharm. ii. 529). Yellow or phagedenic
wash is applied, by means of lint, to venereal and serofulous ulcers.
Dr. Hintze (Brit. and For. Med. Rev. April 1836) used it with advantage
in chronic ulcers which succeed to burns. It should be well shaken
and used in the turbid state.

Hydrargyri-Nitrico-Ox'y'dum.—Nitric-oxide of Mercury.

History.—This preparation was known to Raymond Lully in the
latter part of the thirteenth century. It is commonly termed red pre-
cipitated mercury (mercurius precipitatus ruber), or, for brevity, red pre-
cipitate. It is the oxidum hydrargyrum rubrum per acidum nitricum of
the Edinburgh Pharmacopoeia.

Preparation.—In the London Pharmacopoeia this compound is
directed to be prepared by dissolving three pounds of mercury in a mix-
ture of a pound and a half of nitric acid and two pints (3x1.) of distilled
water. The solution is to be evaporated to dryness, and the residue
reduced to powder; which is to be put in a shallow vessel, and heated by
a slow but gradually increased fire, until red vapours cease to arise.

This compound is best prepared on the large scale, for it cannot be so
well procured of the bright orange-red colour and crystalline or scaly
appearance usually considered desirable, when only small quantities of
materials are employed. Some advise a larger quantity of nitric acid to
be employed than is directed in the London Pharmacopoeia. The reduc-
tion of the nitrate to powder is objectionable, as it diminishes the
crystalline appearance of the oxide. Mr. Brande (Manual of Chemistry)
says, "the nitrate requires to be constantly stirred during the process,
which is usually performed in a cast-iron pot." But in general a shallow
earthen dish is employed, with a second one inverted over it, and care is
taken not to disturb the nitrate during the operation. The heat of the
sand-bath is employed. Indeed, some have asserted that the finest
duct is obtained when the calcination is performed in the same vessel which the nitrate was formed, and without stirring, as directed in the Dublin Pharmacopœia (Dr. Barker, Observ. on the Dubl. Pharm.)

When quicksilver and the diluted nitric acid are digested together, the metal is oxidized at the expense of part of the acid, while binoxide of oxygen escapes, and, combining with oxygen of the air, becomes acetic acid. The oxidized metal unites to some undecomposed acid to form a nitrate. If no heat be applied, a nitrate of the protoxide only is procured; but when heat is employed, a portion of nitrate of the oxide is also produced. The following diagram will explain the formation of the protonitrate:

<table>
<thead>
<tr>
<th>AGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid 54 1 eq. Binoxide of Nitrog.</td>
<td>1 eq. Binoxide Nitrog. 30</td>
</tr>
<tr>
<td>Mercury</td>
<td>73 eq. Oxygen</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>162</td>
</tr>
</tbody>
</table>

When nitrate of mercury is heated, decomposition takes place: the nitric acid is resolved into oxygen and nitrous acid, the first of which combines with the protoxide of mercury, forming therewith the binoxide, while the nitrous acid escapes.

Some pernitrate of mercury usually remains undecomposed, but the quantity is small. Mr. Braude states that 100 pounds of mercury with lbs. of nitric acid (sp. gr. 1.48) yielded 112 pounds of nitric-oxide of mercury. Hence 3 pounds of nitric acid must have remained in combination with the oxide.

PROPERTIES.—It occurs in bright tile-red or scarlet crystalline grains or scales. When quite free from nitrate of mercury, it is insoluble in water; but owing to the presence of a small quantity of nitrate, the nitric-oxide of mercury of commerce is usually slightly soluble in water. Barker (op. cit.) found that 1000 parts of water took up 0.62 of the salt. The other properties and characteristics of this compound are the same as those of the last-mentioned preparation (vide Hydargyri Binoxydum).

STUBILITY.—The presence of some undecomposed nitrate may be recognised by heating the suspected nitric-oxide of mercury, when nitrous vapours are given off, and by boiling in water, when a solution is obtained, from which e-water and hydrosulphuric acid throw down precipitates. The nitric-oxide of mercury is completely dissipated by heat: hence the presence of non-volatile matters (as red-lead) might be readily detected. Heated in the blow-pipe on charcoal, the mercurial oxide is reduced and volatilised, but if red-lead be present, globules of metallic lead will be left undigested.

PHYSIOLOGICAL EFFECTS.—Its local action is that of a powerful irritant (vide Hydargyri Binoxydum). When the nitric-oxide contains 15% of mercury, its topical influence is rendered more energetic. Its constitutional effects are the same as those of other mercurials.

Fabianus Hildanus, Bartholinus, Langius, and Jacobs (quoted by aimer, Wirkung d. Arzneim. iii. 69), have reported cases in which the internal use of this agent gave rise to salivation and other constitutional
effects of mercury. In the case mentioned by Jacob, death resulted from
the application of it to a wart on the face.

Frederic Hoffmann, Ploucquet, Girtanner (Wibmer, op. cit.), and more
recently Mr. Brett (Lond. Med. Gaz. xiii. 117), have related instances of
poisoning by its internal employment.

Uses.—Internally it has been administered in the form of pill in
venereal diseases, but the practice is highly objectionable.

As an external agent it is used in the form of powder (obtained by
levigation) or ointment; the latter is officinal. As a caustic, it is
sprinkled over spongy excrescences, venereal warts, chancrees, indolent
fusious ulcers, &c. Mixed with eight parts of finely-powdered white
sugar, it is blown into the eye with a quill in opacity of the cornea

*Unguentum Hydrargyri Nitrico-Oxydum,* Ph. Lond. and
Dub. (Finely-powdered nitric-oxide of mercury, 3 j.; white wax, 3 j.;
lard, 3vj. Mix. The Unguentum oxid, hydrargyri rubri, Ph. Ed.
consists of nitric oxide of mercury, one part; lard, six parts. Mix.)—This
ointment undergoes decomposition by keeping; its colour changing from
red to grey, in consequence of the partial deoxidation of the nitric-oxide
of mercury. Dr. Duncan (Edinb. Dispens.) says the presence of resin
quickly causes it to become black. It is a valuable stimulant, and is
frequently applied to indolent sores and ulcers, when we require to in-
crease the quantity and improve the quality of the discharge; to inflamed
eye-lids (ophthalmia tarsi); chronic conjunctivitis, &c.

*Hydrargyri Chlōride.*

History.—Beguin in 1608, and Oswald Croll in 1609, are the first
Europeans who mention this compound. Mr. Hatchett (Brandes
Manual of Pharmacy, 2d edit. 328) says it had been long known to the
natives of Thibet. Its discoverer is unknown. It has had a great
variety of names. The term calomel (calomelas, from καλὸς, good,
and μέλας, black) was first applied to it by Sir Theodore de Mayenne
(who died in 1655), in consequence, as some say, of his having had a
favourite black servant who prepared it; or according to others, be-
cause it was a good remedy for the black bile. Drago mitigatus, aqua
alba, manna metallorum, and panchymagogum mineralae, are some of the
appellations for it. Mercurius dulcis, hydrargyrum muriaticum mite
submuriate of mercury, and subchloride, protochloride, or dichloride of
mercury, are some of the modern synonyms of it.

Natural History.—Native calomel or corneous mercury occurs in
crusts, and also crystallized in four-sided prisms terminated by pyra-
mids. It is found at Deux-Ponts, Carniola, and in Spain.

Preparation. (a.) By sublimation.—Chloride of mercury is prepared
by sublimation from a mixture of sulphate of mercury and chloride of
sodium.

In the London Pharmacopœia, two pounds of mercury are directed to
be boiled with three pounds of sulphuric acid, to dryness, by which
bipersulphate of mercury is obtained. When cold, this is mixed, first with
two pounds of mercury, then with a pound and a half of chloride of
sodium, and afterwards sublimed. The sublimate is to be washed with
boiling distilled water, and dried.
In the first stage of this process one equivalent or 202 parts of mercury decompose two equivalents or 80 parts of dry sulphuric acid; and, extracting two equivalents or 16 parts of oxygen, to form one equivalent 218 parts of binoxide of mercury, disengage two equivalents or 64 parts of sulphurous acid. The binoxide combines with two equivalents 180 parts of undecomposed sulphuric acid, forming one equivalent or 8 parts of bipersulphate of mercury.

Mr. Phillips (Translation of Pharmacopoeia, 1836) explains the process somewhat differently. He assumes that the trituration of bipersulphate of mercury converts this salt into the protosulphate of mercury, and at this yields chloride of mercury by the action of chloride of sodium. At the mere trituration of bipersulphate of mercury with metallic mercury cannot be admitted to be sufficient to convert this salt into protosulphate. It is not improbable that bichloride of mercury is first formed by the mutual reaction of bipersulphate of mercury and chloride of bismuth; and that this subsequently combines with mercury, both being the state of vapour, to form calomel. For some bichloride is always mixed with the sublimed calomel, and calomel may be readily obtained by subliming bichloride and mercury: as in the process of the Edinburgh Pharmacopoeia.

At Apothecaries’ Hall, 50 lbs. of mercury are boiled with 70 lbs. of sulphuric acid to dryness in a cast-iron vessel; 62 lbs. of the dry salt are saturated with 40½ lbs. of mercury, until the globules disappear, and 34 lbs. of common salt are then added. The mixture is submitted to heat in earthen vessels, and from 95 to 100 lbs. of calomel are the result. It is washed in large quantities of distilled water, after having been ground to a fine and impalpable powder.

The subliming apparatus varies in different manufactories. In some consists of a large earthen retort, with short but wide neck, opening to an earthen elliptical receiver, in the bottom of which is water. The retort is placed in sand, contained in an iron pot set in a furnace.

The form in which calomel sublimes,” observes Mr. Brande, “depends much upon the dimensions and temperature of the subliming vessels. In small vessels it generally condenses in a crystalline cake, the anterior surface of which is often covered with beautiful quadrangular bismuthic crystals (Brooke, Annals of Philosophy), transparent, and...
of a texture somewhat elastic or horny: in this state it acquires, by the necessary rubbing into powder, a decidedly yellow or buff colour, more or less deep, according to the degree of trituration which it has undergone. If, on the contrary, the calomel be sublimed into a very capacious and cold receiver, it falls in a most impalpable and perfectly white powder, which only requires one elutriation to fit it for use; it then remains perfectly colourless. By a modification of the process, it may be suffered, as it sublimes, to fall into water, according to Mr. Jewell's patent.

"The above circumstances, too, account for the various appearances under which calomel occasionally presents itself in commerce: it may be added, that the buff aspect of this substance indicates the absence of corrosive sublimate; though it by no means follows as a consequence that when snow-white it contains it. When the surface of massive sublimed calomel is scratched, it always exhibits a buff colour: it also becomes yellow when heated, but loses its tint as it again cools." (Manual of Chemistry, 4th ed. p. 788).

Mr. Jewell's process (Repert. of Arts, xiii. 79, 2d Series) for preparing calomel consists in keeping the receiving vessel filled with steam, so that the vapidous calomel is condensed in it, and takes the form of a fine powder, which is much finer than can be obtained by levigation and elutriation. This process has been improved by M. O. Henry (fig. 66).

Henry's modification of Jewell's apparatus for preparing calomel by steam (Hydrosublimate of mercury).

Fig. 66.

(a) Furnace, containing an earthen retort (having a wide and short neck), in which the ingredients for making calomel are placed.

(b) An earthen receiver, having three tubulures: one connecting with the retort; a second dipping into water in an earthen jar, and a third connected to a steam-pipe.

(c) Steam-boiler.

Properties.—The primary form of the crystals of calomel is the right square prism. The appearance of the crystalline cake of sublimed calomel has been already noticed. As met with in the shops, it is in the form of a fine odourless or tasteless powder, whose sp. gr. is 7.176 (7.2 Brande). When prepared by Jewell's process it is perfectly white, but when obtained in the ordinary way has a light buff or ivory tint. It volatilizes by heat, and, under pressure, fuses. It is insoluble in cold water and alcohol. According to Donovan (Ann. Phil. xiv. 323,
and others (Gmelin, Handb. d. Chemie, i. 1299; Geiger's Handb. d. Pharm. by Liebig, i. 561), calomel suffers partial decomposition by long boiling in water, and a solution is obtained which contains mercury and chlorin (bichloride of mercury?).

By exposure to light, calomel becomes dark coloured, in consequence, according to Dumas (Traité de Chimie, iii. 605), of the transformation of small portion into mercury and bichloride. Others have ascribed this change to the evolution of chlorine and combination of the metal with oxygen. Both hypotheses are inconsistent with the statement of Vogel Landgrebe, Ueber das Licht, 97), that this blackened calomel is insoluble in nitric acid. Is it not probable that the change depends on the formation of a subchloride, as Wetzlar has shown to be the case with chloride silver? By digestion in hot and concentrated hydrochloric acid, we obtain bichloride of mercury and reguline mercury. Boiling sulphuric acid forms bipersulphate and bichloride of mercury, with the evolution of sulphurous acid.

Characteristics.—Iodide of potassium produces at first a greyish, afterwards a greenish-yellow precipitate (iodide of mercury). When treated in nitric acid, calomel is converted into bichloride and bipernitrate of mercury; and on the application of the tests already mentioned for mercurial preparations generally, we readily obtain evidence of the presence of mercury. Having thus shown it to be a mercurial compound, we may easily prove it to be calomel by observing that it is insoluble in water, and that on the addition of lime-water a blackish grey precipitate (protoxide of mercury) is obtained, while the supernatant liquor found, on the addition of the nitrate of silver, to give evidence of the presence of chlorine in solution. Protochloride of tin, added to calomel, extracts the chlorine, and becomes bichloride of tin, while globules of metallic mercury are obtained.

Composition.—The following is the composition of calomel:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>84-87</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1</td>
<td>36</td>
<td>15-12</td>
</tr>
<tr>
<td>Chloride of Mercury</td>
<td>1</td>
<td>238</td>
<td>99-99</td>
</tr>
</tbody>
</table>

Purity.—When pure, calomel is completely vaporized by heat, water or alcohol which has been digested on it, should occasion no precipitate or change of colour on the addition of lime-water, caustic potash, ammonia, nitrate of silver, or hydrosulphuric acid, by which the absence of bichloride of mercury may be inferred. I have met with calomel black, in consequence of being imperfectly washed, contained bichloride. It had been given to several patients before its purity was suspected, and had operated on them most violently. When mixed with potash it became black, like pure calomel: the quantity of bichloride being insufficient to produce any perceptible alteration in the colour of the precipitate. But water which had been digested on it, gave, with the above-mentioned tests, the characteristic indications of bichloride of mercury.

Physiological Effects. (a.) On animals.—Wepfer (Hist. Cicat. spat.), Viborg, Flormann (Wibmer, Wirk. d. Arzn.), Gaspard Iagendie, Journ. de Physiol.), and Annesley (Diseases of India), have
examined the effects of calomel on dogs, horses, and pigs, but without any remarkable results. Viborg gave half an ounce, with six pounds of water, to a horse: the effects were cough, heaving of the flanks, quick pulse, enfeebled appetite, and in twenty-four hours loose stools. Amesley asserts, from his experiments on dogs, that large doses of calomel diminish the vascularity of the gastro-intestinal membrane.

(b.) On man.—Calomel may be ranked among the mild preparations of mercury; for although, in its local action, it is somewhat more powerful than the oxide, or than those preparations which contain mercury in a finely divided state (as blue pill), yet it is much milder than any of the other salts of mercury. In small doses, as a few grains, it occasionally excites no obvious effects, though more commonly it acts as a purgative; and in very susceptible persons, especially females, it sometimes produces nausea, griping, and great faintness. It appears, from the experience of most practitioners, that adults are more susceptible of the influence of calomel than children. When given to the latter, it frequently produces green stools, (the so-called calomel stools of Kraus),—an effect which is more frequently observed in suckling infants, and which is usually supposed to arise from the action of calomel on the liver; though Zeller (quoted by Kraus) thinks it depends on alterations produced in the condition of the blood; and Kraus (Heilmittellehre, 161) is disposed to refer it to the operation of calomel on the milk contained in the alimentary canal. (On the Effects of Calomel in producing Slimy Stools, consult Lond. Med. and Surg. Journ. Apr. 1829, 344). Like other mercurials, it increases the action of the secreting organs, and thus promotes the secretion of bile and of intestinal mucous; and we also presume it has a similar influence over the secretion of the pancreatic fluid. Neumann (Gräfe and Walther's Journal, Bd. ii. H. 3. S. 432, quoted by G. A. Riechter, Ausführ. Arzneim. v. 492) states, that a man took two, then three, and subsequently four grains of calomel, daily, for the space of two months, without inducing salivation; but that three months afterwards he became affected with chronic salivation, the consequence of a seirrhous pancreas, of which he died in four months. From the manner in which the case is related, it is clear the narrator attributed the disease of the pancreas to the use of mercury; whether justly or not, however, is impossible to determine.

The repeated and continued use of calomel, in small doses, is attended with the constitutional effects of mercurial preparations generally, before described.

In large doses, it has been regarded as an irritant poison; and, judging from the fatal effects ascribed to it by several writers, not without reason. Thus Hellweg (Wibmer, op. cit. iii. 71) has reported a case in which a few grains of calomel, taken as a laxative, caused death; Vagnitius (Wibmer, op. cit.) saw fifteen grains prove fatal; and Ledelins (ibid.), half an ounce. Fr. Hoffmann has also related two fatal cases (ibid.)

"Whytt, Odier, Quin, Wilmer, Leib, and others," says Gölis (Treatise on the Hydrocephalus Acutus, by Dr. Gooch), "gave calomel internally in far larger doses; as two, three, and more grains at a time; and continued its use many days in the same dose, without considering the many evacuations from the alimentary canal, or the violent colic pains; and they affirm that they have never remarked, from the effect of this agent given in these large doses, any bad consequences in the abdomen."
Melancholy experience compels me to contradict them. Many times
I saw, under those large and long-continued doses of calomel, the
hydrocephalic symptoms suddenly vanish, and inflammation of the
intestines arise, which terminated in death. Still oftener I observed
this unfavourable accident from an incautious use of calomel in croup:
viz. where all the frightful symptoms of this tracheal inflammation,
which threatened suffocation, suddenly vanish, and enteritis developes
itself, which passed rapidly into gangrene, and destroyed the patients."

In the Times newspaper of the 26th April, 1836, there is the report of
a coroner’s inquest on the body of a Mrs. Corby, who was destroyed by
swallowing 20 grains of calomel, she having previously taken a moderate
dose without its exciting what she considered a sufficient effect; and in the
India Journal of Medical Science (Lond. Med. Gaz. xviii. 484) is a
case of a lad, aged 14, a native of Nepal, in whom six grains of calomel
apparently produced inflammation and ulceration of the mouth, enormes
swelling of the face, mercurial effect of the breath, mortification,
and death. There was no ptyalism.

In Pierer’s Annalen for April 1827 (quoted by Wibmer, op. cit. 72),
is the case of a lady, who by mistake swallowed fourteen drachms of
calomel at once. Acute pains in the abdomen came on, accompanied by
frequent vomiting and purging. These symptoms were allayed by
dehiscous demulcents; but on the second day salivation and ulceration of
the mouth took place. In three weeks, however, she was perfectly
recovered. Other violent effects are noticed by Wibmer, Gmelin, and
others; but the instances adduced are sufficient to show that dangerous and
fatal effects may result from large doses, and therefore that Teichmeyer, Buchner, and others, are justified in ranking it among poisons.

Of late years, however, immense quantities of calomel have been
administered medicinally, without giving rise to any symptoms of irritant
poisoning,—nay, apparently with the opposite effect; for we have the
concurrent testimony of many practitioners, that in yellow fever, cholera,
and other dangerous diseases, calomel, in doses of a scruple and upwards,
causes vomiting and purging; and on this account has been denominated
a sedative. So that while in small doses (as from two to five grains)
calomel is almost universally admitted to be an irritant to the bowels, it
is asserted that larger ones are actually sedative. These statements
appear to me to be almost inconsistent, and yet they are fair deductions
from the experience of numerous intelligent practitioners. We must,
therefore, endeavour to accumulate more facts, in order to illustrate the
effects of calomel, and for the present confess we have very imperfect
information respecting the nature of its action.

In a case published by Mr. Roberts in the London Medical Gazette
xxii. 611), an ounce of calomel was swallowed by mistake, and retained
in the stomach for two hours before the error was discovered. The only
effects were slight nausea and faintness. Subsequently, emetics, lime-
water, and purgatives, were administered; calomel was vomited up,
and the day but one afterwards the patient was quite well. Neither
salivation nor the slightest affection of the gums occurred.

The largest quantity of calomel given as a medicinal agent, at one dose,
as I believe, three drachms; "and it was followed," says Dr. Christison
Treatise on Poisons), from whom I quote the case, which occurred in
America, "by only one copious evacuation, and that not till after the use
of an injection." I have now before me reports of eighteen cases of spasmodic cholera, admitted in the year 1832 into the Cholera Hospital at Bethnal Green, in this metropolis, in which enormous quantities of calomel were employed by the house-surgeon, Mr. Charles Bennett (formerly one of my pupils), with very slight physiological effects. When a patient was brought into the hospital, two drachms of calomel were immediately given, and afterwards one drachm every one or two hours, until some effect was produced. In 17 out of 18 cases in which this plan was tried, the vomiting and purging diminished, and the patients recovered. Several of them took from 20 to 30 drachms without the subsequent ptalism being at all excessive. In one case (a female aged 36 years), 30½ drachms were administered within forty-eight hours, moderate ptalism took place, and recovery. In the unsuccessful case which I have alluded to, 53 drachms of calomel were administered within forty-two hours, without the least sensible effect.

Dr. Griffin (Lond. Med. Gaz. xviii. 880) also tells us, that in several cases of cholera he gave calomel hourly, "in scruple doses, to the amount of two or three drachms or upwards, without eventual salivation; and I recollect," he adds, "one instance in particular, in which I gave two drachms within an hour and a half with perfect success, and without affecting the system."

I do not pretend to reconcile these cases with those recorded by Hellweg, Vagnitius, Ledelius, Hoffinan, and Gölis; in fact they appear to me irreconcilable. Dr. Christison, however, suggests that in those cases in which violent effects occurred, the calomel might contain corrosive sublimate.

Mr. Amesley (Diseases of India) accounts for the increased quantity of bile found in the stools after the use of calomel, by supposing that the gall-bladder sometimes becomes distended in consequence of the tenacity of the mucous secretion, by which the mouth of the ductus communis cholec dochus is closed; and that calomel acts chemically on the mucus, and detaches it. But the hypothesis is, I think, devoid of foundation.

Uses.—Calomel is very frequently used as an alternative, in glandular affections, chronic skin diseases, and disordered conditions of the digestive organs, more particularly in those cases connected with hepatic derangement. For this purpose it is usually taken in combination with other alternatives, as in the well-known Plummer's pill, which I shall presently notice.

It is very frequently employed as a purgative, though, on account of the uncertainty of its cathartic effects, it is seldom given alone; generally in combination with other drastic purgatives—such as jalap, scammony, compound extract of eoleoeth, &c. whose activity it very much promotes. We employ it for this purpose when we are desirous of making a powerful impression on the alimentary canal, and thereby of relieving affections of other organs, on the principle of counter-irritation, before explained. Thus in threatened apoplexy, in mental disorders (Finch, Lond. Med. Gaz. iii. 692), in dropsical affections, and in chronic diseases of the skin. In torpid conditions of the bowels, where it is necessary to use powerful cathartics to produce alvine evacuations, as in paralytic affections, it is advantageously combined with other purgatives. Sometimes we use it to promote the biliary secretion—as in jaundice and other affections of the liver, in chronic skin diseases, and in various disordered
tions of the alimentary canal not accompanied by inflammation. Moreover, in the various diseases of children requiring the use of purgatives, it is generally considered to be very useful; and its being devoid of this is of course an advantage.

As a sedative it has been administered in yellow fever, spasmodic or malignant cholera, dysentery, and liver affections (vide p. 469). Dr. Griffin (Lond. Med. Gaz. xxii. 880) asserts that calomel was a most successful medicine in cholera, controlling or arresting its progress, in 84 cases out of 100, if administered while the pulse was perceptible at the wrist; but, on the contrary, detrimental when given in collapse. The practice was tested in 1448 cases. The dose was from one to two scruples every hour or half-hour.

As a sialagogue, it may be used in the cases in which I have already mentioned (p. 448) that mercurials generally are employed: with the view of preventing irritation of the alimentary canal, it is usually given in combination with opium, unless, indeed, the existence of some affection of the nervous system seem to contraindicate the use of narcotics. This combination is employed in peripneumonia, pleuritis, croup, laryngitis, hepatitis, enteritis, and other inflammatory diseases; in fever, syphilis, chronic visceral diseases, &c.

Calomel is frequently combined with other medicines, to increase their effects; as with squills, to produce diuresis, in dropsy; or with antimonials, to promote diaphoresis.

As an anthelmintic it is in frequent use, and forms one of the active ingredients of many of the nostrums sold for worms; though it does not appear to have any specific influence over parasitic animals.

The local uses of calomel are numerous. In diseases of the Schmidegen membrane, it is applied as a snuff. It is sometimes blown into the eye, to remove spots on the cornea. Dr. Fricke (Lond. Med. Gaz. xxii. 97) has used it with great success in chronic cases of rheumatic, haemorrhoidal, and scrofulous ophthalmia; but in two instances bad consequences resulted from its use. It is sometimes suspended in thick unguent, and used as a gargle in venereal sore-throat, or injected into the urethra in blennorrhoea. Now and then it is used as a substitute for laudanum in febrile states.

As a local application, in the form of ointment, calomel is one of the most useful remedies we possess for the cure of some forms of skin diseases, as will be presently noticed.

Administration.—When used as an alterative, it is given in doses of from half a grain to a grain, frequently combined with oxysulphuret of antimony (as in Pil. Hydr. Chlor. Co.) or antimonial powder, and repeated every or every other night; a mild saline laxative being given the following morning; as a purgative, from two to five grains, usually in combination with, or followed by, the use of other purgatives, especially jalap, nitric, ammoniacal, or coloemulch; as a sialagogue, in doses of one to three or four grains, generally combined with opium or Dover’s powder, twice or thrice a day; and, as a sedative, from a scruple to half a drachm, or even more than this, as already mentioned. Biett (Lond. Med. Gaz. viii. 540) has sometimes employed it as an errhine, in syphilitic eruptions. It is fixed with some inert powder, and given to the extent of from 8 to 20 grains daily. The use of acids with calomel frequently occasions gripping. Calomel is most extensively employed in the diseases of children, and may be given to them in as large or larger doses proportionally as to
adults. Salivation is a rare occurrence in them; indeed, Mr. Colles (Pract. Observ. p. 281) asserts, that mercury never produces ptyalism, or swelling or ulceration of the gums, in infants.

*Pilula Hydragryri Chloridi Compositae*, Ph. Lond.; *Pilula Calomelanos Compositae*, Ph. Dubl.; *Pilula Sub-muriatis Hydragryri Compositae*, Ph. Edinb.; *Plummer’s Pills*, or *Pilula Plummeri* (chloride of mercury; oxysulphuret of antimony, 3ij.; guaicum resin, powdered, 3ss.; treacle, 5ij. M. The Edinburgh College uses mucilage of gum arabic instead of treacle).—These pills are frequently employed as alteratives in chronic skin diseases, in the papular and pustular forms of the venereal disease, in chronic liver affections, and in various disordered conditions of the digestive organs. The dose is from five to ten grains.

*Pilula Cathartica Compositae*, Ph. U. S. (Compound extract of colocynth, 3ss.; extract of jalap, in powder; calomel, 3ij.; gamboge, in powder, 3ij. M. Divide into 180 pills). This pill is intended to combine smallness of bulk with efficiency and comparative mildness of purgative action, and a peculiar tendency to the biliary organs (United States Dispensatory). Each pill contains one grain of calomel. Three pills are a full dose.

*Unguentum Hydragryri Chloridi* (calomel, 5j.: lard, 5j. M.) This is a most valuable application in porrigo favosa, impetigo, herpes, and the scaly diseases (psoriasis and lepra). Indeed, if I were required to name a local agent pre-eminently useful in skin diseases generally, I should fix on this. It is well deserving a place in the Pharmacopoeia.

*Hydragryri Bichloridum.—Bichloride of Mercury.*

**History.**—We have no account of the discovery of this preparation. Geber (Inv. of Ver. viii. 252) described the method of preparing it; but it is supposed to have been known long anterior to him. Like calomel, it has had various synonyms, of which the principal are the following: chloride, hydrochlorate or muriate of mercury (hydrargyri chloridum, hydrochloras seu muriias), corrosive sublimate (mercurius sublimatus corrosivus), corrosive muriate of mercury (hydrargyri murias corrosivus), and acidum chloro-hydrargyricum.

**Preparation.**—Mercury and sulphuric acid are boiled together, as in the process for making calomel; and the bipersulphate of mercury is sublimed with chloride of sodium, without the addition of metallic mercury. The sublimation is usually effected in an earthen alembic, placed in sand.

The nature of the changes which occur in the manufacture of bipersulphate of mercury have been already explained (p. 465). When this salt is sublimed with chloride of sodium, double decomposition takes place, and we obtain bichloride of mercury and sulphate of soda.

<table>
<thead>
<tr>
<th>REAGENTS</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 eq. Chloride Soda</td>
<td>1 eq. Bichlor. Merc. 254</td>
</tr>
<tr>
<td>2 eq. Sodium</td>
<td>2 eq. Chlorine</td>
</tr>
<tr>
<td>2 eq. Oxygen</td>
<td>1 eq. Mercury</td>
</tr>
<tr>
<td>1 eq. Bipersulphate Mercury</td>
<td>2 eq. Sulphur. Acid</td>
</tr>
</tbody>
</table>

**Properties.**—As usually met with in commerce, bichloride of mercury is a semi-transparent crystalline mass, in which perfect crystals are rarely found. Occasionally, however, they are obtained either by slow
BICHLORIDE OF MERCURY.

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limation, or from a solution of the salt. Their primary form is the rhombic prism. The sp. gr. of this salt is about 5·2 (5·14 to 5·42, big). The taste is acid, coppery, and persistent. When heated it es, boils, and volatilizes: the vapour is very acrid. It is soluble in but three times its weight of boiling, and in about eighteen or twenty es its weight of cold water: the acids (especially hydrochloric) and alkaline chlorides increase its solubility. It is soluble in seven parts cold or three and a half parts of boiling alcohol. Ether dissolves it re readily than alcohol, and will even separate it from its watery solu; and hence is sometimes employed to remove it from organic utures.

An aqueous solution of bichloride of mercury readily undergoes de- position, especially when exposed to solar light; calomel is precipi- ed, and hydrochloric acid set free. This change is facilitated by the ence of organic substances,—as gum, extractive, or oil; whereas it ehecked by the presence of alkaline chlorides.

Albumen forms a white precipitate with an aqueous solution of bichlo- of mercury. This precipitate is slightly soluble in water, and con- es, according to Lassaigne (Journ. de Chim. Méd. iii. 2d series, 161), albumen, 93·45, and bichloride of mercury, 6·55; so that it is a argyro-chloride of albumen. Fibrin forms a similar white compound or corrosive sublimate. When albuminous and fibrinous textures emmersed in a solution of this salt, combination takes place, tisue contracts, increases in density, becomes whiter, and does not eefy. Hence it is employed by the anatomist for hardening and pre- ing certain parts of the body—as the brain.

Bichloride of mercury possesses some of the characters of an acid. s it reddens litmus, and unites with the chlor-bases (as chloride of um), which in consequence restore the blue tint of litmus, which had n reddened by the mercurial bichloride. The salts which result to the combination of the two chlorides are called hydrargyro- erides.

CHARACTERISTICS.—Bichloride of mercury is known to be a mercurial ound by the following characters:—

Heated in a tube by a spirit lamp, with caustic potash, an alkaline oride is formed, oxygen gas is evolved, and metallic mercury is su- sed and condensed in the form of globules on the sides of the tubes.

Lime-water causes a lemon-yellow precipitate; an additional quant- of the precipitant water produces a brick-dust red precipitate, while a er quantity restores the yellow colour. The yellow-coloured preci- e is the hydrated binoxide; the reddish-coloured precipitate is the hloride.

Caustic ammonia, added to a solution of bichloride, causes hydro- rate of ammonia to be formed in solution, while a white powder argyri ammonio-chloridum) is thrown down.

The alkaline carbonates throw down a brickdust-coloured precipi- the bicarbonates a white one.

Iodide of potassium occasions a scarlet precipitate of the biniodide erycury; but the precipitate frequently appears at first of a yellow ur, though it quickly becomes scarlet. Dumas (Traité de Chimie, iii. thinks these yellow and red states of the biniodide depend on some erie phenomena requiring further examination. If an excess of
iodide of potassium be employed, the red precipitate disappears, owing to the formation of a soluble double salt, in which the biniodide of mercury acts the part of an acid, and the iodide of potassium that of a base. This double salt may be called the hydrargyro-iodide of potassium. Bichloride of mercury and the biniodide of mercury also form a double salt: hence, if a great excess of the former salt be employed, the red precipitate disappears, owing to the formation of a soluble double salt.

6. Protochloride of tin occasions, with bichloride of mercury, a white precipitate of calomel, while perchloride of tin remains in solution. Very shortly this protochloride of mercury is converted into reguline mercury, which falls down in a finely divided state as a greyish powder.

7. Hydrosulphuric acid in excess, passed through a solution of bichloride of mercury, occasions a black precipitate of the bisulphuret of mercury: a solution of hydrochloric acid is formed. If the hydrosulphuric acid be not in excess, a white precipitate of the chloro-sulphuret of mercury is obtained, and which consists of two atoms bisulphuret of mercury and one of the bichloride.

8. Ferrocyanide of potassium causes a white precipitate (ferrocyanide of mercury).

9. Albumen is another test for corrosive sublimate, though not one of much value, since it will produce the same white precipitates with many other substances.

10. Galvanism.—Drop the suspected solution on a piece of gold, as a sovereign, and apply a key, so that it may touch, simultaneously, the gold and the solution; an electric current is immediately produced, the bichloride is decomposed, the mercury attaches itself to the negative electrode (or pole), namely the gold, while the chlorine unites with the iron of the positive electrode (or pole) to form chloride of iron. The relative position of the gold, the key, and the solution, will be evident from the fig. 67; and the arrows point out the direction of the electric current. The silver stain left on the gold is readily removed by heat. In Dr. Christison's work will be found other methods of applying galvanism; but the one just mentioned is perhaps the most useful, since it can always be readily made use of; whereas a more complicated apparatus is found in the hands of a few persons only. Thus it might be applied at a moment's notice to detect corrosive sublimate in the matters vomited by a patient.

The relative delicacy of some of these tests is thus stated by Devergie (Méd. Lég. ii. 676):

<table>
<thead>
<tr>
<th>Test</th>
<th>Degree of Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrocyanide of potassium</td>
<td>stops at 1,500</td>
</tr>
<tr>
<td>Lime water</td>
<td></td>
</tr>
<tr>
<td>Potash or its carbonate</td>
<td></td>
</tr>
<tr>
<td>Iodide of potassium</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td></td>
</tr>
<tr>
<td>Hydrosulphuric acid, or hydrosulphate of ammonia</td>
<td></td>
</tr>
<tr>
<td>Protochloride of tin, or galvanic pile</td>
<td></td>
</tr>
</tbody>
</table>

The preceding tests have not determined the nature of corrosive sublimate, farther than that it is a permercurial salt. To prove that it is chloride, the simplest method of proceeding is to add to the suspected
BICHLORIDE OF MERCURY. 475

tion, lime-water, or carbonate of soda; then filter, and test the clear
filtrate with nitrate of silver, which causes a white precipitate if any
silver be present (vide p. 105). If nitrate of silver be added to a
solution of bichloride of mercury, we obtain a white precipitate of chloro-
silver, but mixed with calomel; and it is to avoid the production
of the latter substance that I prefer the method of testing just men-
tioned.

COMPOSITION.—The composition of this salt is as follows:

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>73.72</td>
<td>73.53</td>
</tr>
<tr>
<td>Chlorine</td>
<td>2</td>
<td>72</td>
<td>26.27</td>
<td>26.47</td>
</tr>
<tr>
<td>Bichloride of Mercury</td>
<td>1</td>
<td>274</td>
<td>99.99</td>
<td>100.00</td>
</tr>
</tbody>
</table>

SOLUBILITY.—Pure bichloride should be white, dry, totally vapourized by
heat, and completely soluble in water, alcohol, or ether.

PHYSIOLOGICAL EFFECTS. (a.) On vegetables.—The effects of solu-
tions of bichloride of mercury on plants have been examined by Seguin,
subsequently by Marcet and Macaire (Decandolle, Phys. Vég. 1832),
from their experiments it appears, that when growing plants are
soaked in a solution of this salt, part of the poison is absorbed, a
white or transparent film is formed on the surface of the leaves or stems;
the effect on the irritable portion of the Berberis vulgaris, and
the leaves of the Mimosa pudica, being the same as that produced by
nic (p. 384). Bichloride of mercury is equally poisonous to crypto-
trophic plants. Hence vegetable tissues soaked in a solution of it are no
more adapted for the development of the Merulius lachrymans, and of
fungi known under the name of the dry-rot. This, in fact, is the
principle adopted by Mr. Kyan (Lond. Med. Gaz. xvi. 630) for the pre-
paration of timber, and which is now practised by the Anti-Dry-rot
Company.—(Vide Dr. Dickson’s Lecture on Dry-rot, 1837.)
(b.) On animals generally.—The effects of corrosive sublimate on ani-
mal functions have been examined by Ettmüller, Wepfer, Sprægel, Sir Benjamin
Aldie (Phil. Trans. for 1812), Campbell, Lavort, Smith, Gaspard, Orfila
(med. gén.), Schubarth, and Bostock. An abstract of these will be
found in the works of Wibmer (Würk. d. Arzn. u. Gifte), and Christison
(Rev. on Poisons). Dogs, cats, horses, rabbits, and frogs, are the ani-
mals on which the experiments have been tried, and on which sublimate
has been found to exercise a poisonous operation, and the same kind of
result is presumed, from analogy, to be produced on all other animals.
The results of these experiments have been so briefly yet clearly stated
by Dr. Christison, that I cannot do better than quote his words:—“Cor-
rosive sublimate poisoning, when swallowed, corrosion of the stomach; and
whatever way it obtains entrance into the body, irritation of that organ
of the rectum, inflammation of the lungs, depressed action, and per-
haps also inflammation of the heart, oppression of the functions of the
lungs, and inflammation of the salivary glands.” I may add, that mer-
al in the body and salivation have been observed in horses, dogs, and
frogs.

(c) On man.—a. In small or therapeutic doses, as from one-eighth to one-
eth of a grain, it frequently exerts a beneficial effect on diseases (syphil-
erruptions, for example), without producing any obvious alteration in
actions of the different organs. Occasionally, especially when the
stomach and bowels are in an irritable condition, it gives rise to a sensation of warmth in the epigastrium, and causes nausea, griping, and purging. In such cases it is best to diminish the dose, and conjoin opium. By repetition we frequently observe that the pulse becomes somewhat excited and if the skin be kept warm, perspiration is oftentimes brought on; a other times the quantity of urine is increased. Continued use of stomach purging, violence in the alimentary canal (particularly in the stomach and rectum), loss of appetite, nausea, vomiting, purging, and disordered digestion, are the gastro-enteric symptoms. The pulmonary organs also not unfrequently become affected; the patient complains of dry cough, pain in the chest, disordered respiration, and bloody expectoration. Coupling these symptoms with the specific effects said to be produced by the lungs of animals by the use of corrosive sublimate, we have an important caution not to administer it to patients affected with pulmonary disorders,—a caution, indeed, which Van Swieten gives; “for those says he, “who have a husky dry breast, are troubled with a cough whose nervous system is excessively irritable, and are subject to hemorrhage, bear not this remedy without detriment.”

γ. Acute poisoning,—In very large doses corrosive sublimate acts as caustic poison, in virtue of its affinity for albumen, fibrin, and other constituents of the tissues. I shall follow Dr. Christison, and admit two varieties of poisoning by it; in one of which “the sole or leading symptoms are those of violent irritation of the alimentary canal. In another variety the symptoms are at first the same as in the former, but subsequently become conjoined with salivation and inflammation of the mouth, or some of the other disorders incident to mercurial crepitation, as it is called.”

First variety: Gastro-enteritis.—In this variety the symptoms are analogous to those of other corrosive poisons: namely, violent burning pain in the mouth, throat, esophagus, and stomach; difficulty of digestion; sense of suffocation; nausea; violent vomiting (increased by every thing taken into the stomach) of mucous, bilious, or sanguineous matters. The pain soon extends from the stomach over the whole abdomen, which becomes acutely sensible to the slightest impression; violent purging, often of blood; inexpressible anxiety; flushed countenance; restlessness; pulse quick, small, and contracted; cold sweats; burning thirst; short and laborious respiration; urine frequently suppressed; and, lastly, various indications of a disordered condition of the nervous system.
BICHLORIDE OF MERCURY.

The symptoms begin much sooner.
The taste is much more unequivocal and strong.
The acridity and irritation in the gullet is much greater.
The countenance is flushed, and even swollen; whereas, in poisoning by arsenic, usually contracted and ghastly.
Blood is more frequently discharged by vomiting and purging.
Irritation of the urinary passages is more frequent.
Nervous affections are more apt to come on during the first inflammatory stage.
The effects are more curable than those of arsenic.

Deviations in the symptoms are more rare.

Second variety: Gastro-enteritis, accompanied with or followed by curial erethysm.—I here use the term erethysm in the sense in which it is employed by Dr. Chistison—namely, to indicate all the secondary effects of mercury. In this variety, the symptoms first observed are mentioned for the last variety, but they are followed, sooner or later, by those of inflammation of the salivary glands, and of the mouth and its neighbouring parts; profuse salivation, ulceration of the mouth, shortness of breath, and other symptoms of this kind, already described, (p. 444.)

USES.—Internally, it has been employed as a sialogogue, alterative, and diaphoretic.

The celebrated Baron Van Swieten (op. cit.) may be regarded as the principal introducer of corrosive sublimate into practice as a remedy for venereal diseases. He seems to have been led to its employment from a conviction that salivation was not requisite for curing this class of diseases; hence he was desirous of obtaining some mercurial “that could be acted at will, and so tried in a very small dose.” Now corrosive sublimate possessed these properties, and hence he commenced his experiments with it; and, meeting with great success, recommended it to his contemporaries, whose results I have already stated. (For further historical details respecting its use, vide Pearson’s Observations on the effects of various Articles of the Mat. Med. p. 99, &c.) The abundance of evidence is decidedly favourable to the employment of this medicine as an internal remedy for venereal diseases. By its partizans it has been asserted to be a safe and efficacious mercurial, to remove real symptoms in a very short space of time, and without causing irritation, merely by exciting diaphoresis. Its opponents (vide Pearson, vide) state, on the other hand, that other mercurials are quite as efficacious and speedy; that the cure by corrosive sublimate is not permanent; lastly, that its corrosive and irritant properties render its employment objectionable. One of the latest advocates for its use is Dzondi, of Halle, "zuverlässig. Heilart. d. Lusts. in allen ihren Formen, &c. 1826, in..."
in Richter, *Ausz. Arzn.* v. 596), who states, the best mode of using bichloride of mercury is in the form of pills made with crumb of bread and he gives the following formula for their preparation:—Hydr. Sublim. Corros. gr. xij., solve in Aq. Distill. q. s., add Micae Pantis Albi, Sacchar. Albi, aa. q. s. ut ft. pilulæ numero cclx. Of these pills (each of which contains one-twentieth of a grain of corrosive sublimate), four are to be administered daily, and increased until thirty (containing one grain and a half) are taken at a dose. The best time of exhibiting them is at dinner. In irritable subjects and painful affections, a few drops of the tincture of opium may be taken with each dose. During the time the patient is under their influence, he should adopt a sudorific regime (as is also recommended by Van Swieten), and take decoction of sarsaparilla.

In acute diseases few have ventured to employ bichloride of mercury; however, Schwartz gave it in hepatitis after the fever and pain had subsided; Sauter employed it in an epidemic scarlet fever; and Bereud administered it in asthenic malignant fevers (Richter, *Auszüg Arzneim.* v. 581). I have already noticed (p. 446) Mr. Lempriere’s proposal to use it in fever, as a dialogogue.

In various chronic diseases it has been given as an alterative and diaphoretic, with occasional success. Thus in rheumatism, diseases of the bones, periodical pains, skin diseases, scrofulous affections, disorder of the nervous system, &c. In such it should be associated with diaphoretics (as antimony, sarsaparilla, &c.), warm clothing, &c. No unfrequently opiates should be combined with it.

As an external remedy it has been applied as a caustic in substance (either alone or combined with arsenic) to cancerous ulcers, to parts bitten by rabid animals, to chancers, &c.: used in this way, however, it is mostly objectionable. In onychia maligna it is used with great advantage, mixed with an equal weight of sulphate of zinc, and sprinkled thickly upon the surface of the ulcer, which is then to be covered with pledget of lint saturated with tincture of myrrh (United States Dispensatory). A solution has been employed for various purposes: thus by Baumé, as already mentioned (p. 448), for pediluvia, to produce salivation; as a lotion in chronic skin disease (as leprosy, psoriasis, scabies, rosacea, &c.); as a wash to ulcers, particularly those of a venereal nature; as an injection in discharges from the urinary organs; as collyrium in chronic diseases of the eye, especially those of a venereal nature; and as a gargle in ulcers of the tonsils. A solution is sometimes used as a preventive for the venereal disease.

**Administration.**—It may be used internally, in substance or solution. The dose of it in substance is from one-sixteenth to one-eighth of a grain. Some advise it to be given to the extent of one-fourth of a grain; but in this dose it is very apt to grippe and purge. Dzondi’s formula, already given, may be employed when we wish to administer it in substance.

In solution it may be exhibited dissolved in water (vide *liquor hydrargyri bichloridi*), alcohol, or ether.

For external use, a watery solution may be employed, containing from half a grain to two or three grains, dissolved in one ounce of water. *Liquor Hydrargyri Bichloridi*, Ph. L. (Bichloride of mercury; hydrochlorate of ammonia, 141 gr. x; distilled water, 3xx. Dissolve).—Hydrochlorate of ammonia is used to increase the solvent pow
the water. Each fluidounce contains half a grain of corrosive sublimate. The dose of this solution is from half a fluidrachm to two or three fluidrachms, taken in some bland liquid, as linseed tea.

**Antidotes.**—Several substances which decompose corrosive sublimate have been employed as antidotes. These are, albumen, gluten of wheat (as contained in wheaten flour), milk, iron filings, and meconic acid.

I have already alluded to the decomposition of corrosive sublimate by albumen. The compound which results from their mutual action appears to be inert, or nearly so. In Dr. Christison's *Treatise on Poisons* will be found several cases noticed, in which albumen has been most effectual: of the most interesting of which is that of Baron Thenard, the celebrated chemist, who inadvertently swallowed a concentrated solution of corrosive sublimate, but by the immediate use of whites of eggs suffered no material harm. Peschier states, that one egg is required for every grain of the poison. *Gluten of wheat* has been recommended by Liddel, and may be employed when albumen is not procurable. Wheaten flour (which contains gluten) will probably answer as well as the pure gluten. *Milk*, in the absence of albumen or flour, may be used. *Iron filings* are said to be useful, by reducing the corrosive sublimate to the metallic state. *Meconic acid* is also said to be an antidote, by forming an insoluble carbonate of mercury. But a knowledge of the fact is of little practical use, since the acid is not generally procurable; and tincture of opium, which contains it, cannot be safely used in sufficient quantity; for Dr. Christison finds that five grains of corrosive sublimate require an infusion of 33 grains of opium to precipitate the whole of the mercury.

The other parts of the treatment for acute poisoning by corrosive sublimate are the same as for other irritant poisons, and consist of the usual phlogistic system—the warm baths, opiates, &c.

**Hydrargyri Ammonio-Chloridum.**—*Ammonio-Chloride of Mercury.*

**History.**—This compound was discovered by Raymond Lully, in the sixteenth century. Lemery pointed out two modes of procuring it, and one it is sometimes termed *Lemery's white precipitate,* to distinguish it from precipitated calomel, also called on the Continent white precipitate. There had various other appellations, as *cosmetic mercury* (mercurius ammoneticus), *white precipitated mercury* (*hydrargyrum precipitatum*) ammon. and, according to the view taken of its composition, it has been called *muriate of ammonia and mercury,*—ammoniated submuriate of mercury (*hydrargyri submuriatus ammoniatum,* Ph. Dub.), ammoniated mercury, (Ph. U. S.), ammonio-chloride of mercury (*hydrargyri ammoniochloridum,* Ph. Lond.), ammoniacal oxychloruret of mercury (*Guibourt*).

**Preparation.**—It is directed, in the London Pharamcopoeia, to be secured by adding eight fluidounces of solution of ammonia to six ounces of chloride of mercury previously dissolved, by the aid of heat, to six parts of distilled water, and allowed to cool. The precipitated powder is to be washed until void of taste, and then dried.

The explanation of the changes which occur in this process varies

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**AMMONIO-CHLORIDE OF MERCURY.**

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according to the view taken of the constitution of the resulting compound. Sal ammoniac (hydrochlorate of ammonia), but no mercury, is certainly left in solution, so that the precipitate cannot contain so much chlorine as bichloride of mercury. It is probable, therefore, that the mercury from which the chlorine has been removed becomes oxidized by the water, though, according to Dr. Kane (Trans. Royal Irish Acad. xvii. 423,) this does not take place. The binoxide of mercury, with some mercurial bichloride, and ammonia, precipitate in combination. The following diagram explains the changes according to this view:

**REAGENTS.**

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<tr>
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</thead>
<tbody>
<tr>
<td>Binoxide of Mercury</td>
<td>1</td>
<td>218</td>
<td>80·14</td>
<td>82·2</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>1</td>
<td>37</td>
<td>13·60</td>
<td>(\frac{10}{7})</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>17</td>
<td>6·25</td>
<td>(\frac{7}{1})</td>
</tr>
</tbody>
</table>

**RESULTS.**

1. 2 eq. Hydrochlor. Ammonia | 109 |
2. 2 eq. Hydrochlor. Acid | 74 |
3. 2 eq. Water | 18 |
4. 2 eq. Oxyg. | 16 |
5. 2 eq. Hydr. | 2 |
6. 2 eq. Ammonia | 34 |
7. 2 eq. Chlor. | 72 |
8. 1 eq. Mercury | 274 |
9. 1 eq. Binox. Mv. | 218 |
10. 1 eq. Biclr. Mercury | 202 |
11. 2 eq. Ammon. Chlor. Mercury | 552 |

If we suppose two equivalents or 18 parts of water to be given out by one equivalent or 526 parts of ammonio-chloride of mercury, the residue will have the precise elementary composition assigned by Dr. Kane to white precipitated mercury.

**Properties.**—It occurs in commerce in masses or in powder. It is white, inodorous, has a taste at first earthy, afterwards metallic. It is decomposed and dissipated by heat, giving out ammonia, nitrogen, calomel, and water. It is insoluble in alcohol. By boiling in water we obtain a solution of hydrochlorate of ammonia, and a yellow powder (white precipitated mercury and binoxide of mercury.—Kane.) It is soluble in sulphuric, nitric, or hydrochloric acid.

**Characteristics.**—When heated with caustic potash, it gives out ammonia, and forms a yellow powder (white precipitated mercury and binoxide of mercury.—Kane). The solution contains chloride of potassium, and with nitrate of silver causes a white precipitate (chloride of silver), insoluble in nitric acid, but soluble in ammonia. Protochloride of tin decomposes white precipitated mercury, and separates metallic mercury. To these characters must be added the effect of heat, water, and acids, on it, as above mentioned.

**Composition.**—The analyses of Mr. Hennell (Quart. Journ. of Science, xviii. 297) and Mitscherlich (Ann. Chim. xxxv. 428), agree in showing the constituents of white precipitate to be those of binoxide of mercury and hydrochlorate of ammonia, in the following proportions:

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<tbody>
<tr>
<td>White Precipitate</td>
<td>1</td>
<td>272</td>
<td>99·99</td>
<td>106·0</td>
</tr>
</tbody>
</table>

This composition is adopted by Berzelius. But in explaining the theory of the formation of white precipitate, I have assumed, with Mr. Phillips (Transl. of the Lond. Pharm.), a somewhat different view of the subject. Two equivalents of white precipitate, according to Mr.
Iodide of Mercury.

Eq.  Eq.Wt.  Per Cent.
Bichloride of Mercury  .  1  .  274  .  52'09
Binoxide of Mercury  .  1  .  218  .  41'44
Ammonia  .  2  .  34  .  6'46
White Precipitate (Phillips)  .  1  .  526  .  99'99

If two more equivalents of water be abstracted, we have the compo-
nion of white precipitate, according to Dr. Kane.

Eq.  Eq.Wt.  Per Cent.
Bichloride of Mercury  .  1  .  274  .  53'93
Bichloride of Mercury  .  1  .  234  .  46'06
White Precipitate (Kane)  .  1  .  508  .  99'99

Purity.—This compound is largely adulterated with sulphate of
mercury; I have one sample containing one-third of its weight of this
substance. Carbonate of lime and of lead are sometimes employed to
alterate white precipitate. Pure white precipitate, thrown on a red-hot
bell, is dissipated without any residuum: whereas the above impuri-
ties remain. The carbonates are recognised by the effervescence on
the addition of hydrochloric acid. Sulphate of lime may be detected by
dissolving the suspected substance in distilled water, and applying the tests
for sulphates and calcareous salts, as before directed (pp. 265 and 343).

Physiological Effects.—Its action on the body is very imperfectly
known: no modern experiments having been made with it. It is usually
considered to be highly poisonous, and somewhat similar in its operation
to bichloride of mercury. Palmarius and Naboth (Wibmer, Wirk. d.
Pharm. iii. 64) have reported fatal cases of its use (vide also Gmelin, App.
Indic. ii. 166).

Uses.—It is employed as an external agent only; commonly in the
form of an ointment. It is an efficacious application in various skin dis-
ases—as porrigo, impetigo, herpes, and even scabies; also in oph-
thalmia tarsi. Among the lower classes it is commonly used to destroy
fleas.

Unquemtun Hydrargyri Ammonio-chloridi, Ph. Lond., Dubl.
A. U. S. (ammonio-chloride of mercury, 3 j.; lard, 3 iss. M.)—It is a
milant, alterative, and detergent.

Hydrargyri Iodidum.—Iodide of Mercury.

Preparation.—This compound, sometimes called protiodide of mer-
cury, is directed, in the London Pharmacopoeia, to be prepared by
boiling together an ounce of mercury and 6} drachms of iodine, adding
gradually as much alcohol as may be sufficient, until globules are no
longer visible.

In this process the mercury and iodine enter into combination. The
alcohol facilitates the union by dissolving the iodine.

Properties.—It is a greenish-yellow powder, whose sp. gr. is 7'75.
It is insoluble in water, alcohol, or an aqueous solution of chloride of
sodium; but is soluble in ether, and slightly so in an aqueous solution of
chloride of potassium. When heated quickly, it fuses and sublimes in red
stals, which subsequently become yellow. Solar light decomposes it,
and changes its colour. Heated with potash, it yields iodide of potassium and reguine mercury.

**Composition.**—It consists of

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<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
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<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>61.58</td>
</tr>
<tr>
<td>Iodine</td>
<td>1</td>
<td>126</td>
<td>38.41</td>
</tr>
<tr>
<td>Iodide of Mercury</td>
<td>1</td>
<td>328</td>
<td>99.99</td>
</tr>
</tbody>
</table>

**Physiological Effects.**—It is a powerfully irritant poison. A scruple killed a rabbit within twenty-four hours, and a drachm a pointer-dog in five days (Cogswell, *Essay on Iodine and its Compounds*, 160).

In small but repeated doses, it appears to exercise a specific influence over the lymphatic and glandular system. Two grains taken daily caused salivation in two instances (Biett, *Lancette Francaise*, Juin 1831).

**Uses.**—It has been used in syphilis and scrofula, especially when they occur in the same individual. Lugol (*Essays on the Effects of Iodine in Scrofulous Disorders*, by Dr. O'Shaughnessy, p. 170) employed an ointment of it in those forms of external scrofulous disease which resemble syphilis. Ricord (*Lancette Franc.* 1834, No. 65) gave it internally with good effect in *syphilis infantum*. Biett (O'Shaughnessy's *Transl. of Lugol's Essays*, p. 201) has successfully employed it in syphilitic ulceration and venereal eruptions.

**Administration.**—The dose of it for adults is from one grain gradually increased to three or four. Ricord gave from one-sixth to one-half of a grain to children of six months old. Biett employed it internally, and also externally, in the form of ointment, to the extent of twelve or fourteen grains daily, by the way of friction.

**Pillae Hydrargyri Iodidi,** Ph. Lond. (iodide of mercury, 3j.; confection of dog-rose, 5ijj.; ginger, powdered, 5j. M.)—Five grains of these pills contain one grain of the iodide. The dose, therefore, will be from five grains to a scruple.

**Unguentum Hydrargyri Iodidi,** Ph. Lond. (iodide of mercury, 3j.; white wax, 5ijj.; lard, 5vj. M.)—This is used as a dressing for scrofulous ulcers, or for syphilitic ulcers in scrofulous subjects. It is also employed in tuberculous skin diseases, as lupus, rosacea, and sycosis. (Rayer, *Treat. on Skin Diseases.*)

**Hydrargyri Biniodide.**—*Bini*odide of *Mer*cury.

**Preparation.**—There are two methods of preparing this compound. The process given in the London Pharmacopoeia is as follows:—An ounce of mercury and ten drachms of iodine are to be rubbed together, alcohol being gradually added until the globules are no longer visible. The powder is to be dried with a gentle heat, and kept in a well-stopped vessel. The alcohol facilitates the combination of iodine and mercury, as in the process for making the protiodide.

Biniodide of mercury may also be prepared by adding a solution of bichloride of mercury to one of iodide of potassium so long as any precipitate takes place. 274 grains of bichloride will be required to decompose 332 grains of iodide of potassium: these proportions are about 8 of the first to 10 of the second. In this process double decomposition takes place: biniodide of mercury precipitates, while chloride of potassium remains in solution. If excess of iodide of potassium be employed, it
ains some biniodide of mercury in solution. It is better, however, to
have a slight excess of iodide of potassium, in order to obtain the mer-
curial biniodide free from corrosive sublimate.

**Properties.**—It is a scarlet red powder, whose sp. gr. is 6.32. It is
soluble in water, but soluble in alcohol, some acids, alkalies, and solu-
tions of iodide of potassium, chloride of sodium, and of many of the mer-
curial salts. From its solution in boiling rectified spirit it is deposited,
cooling, in rhombic prisms. When heated it fuses, forming a ruby-
dred liquid, sublimes in crystals, which are at first yellow but afterwards
come red, and furnish a scarlet-red powder. It combines with other
saline iodides (as iodide of potassium) forming a class of double salts,
alled the *hydrargyro-iiodides.*

**Characteristics.**—Heated with potash in a tube it yields metallic
mercury, which is volatilized: the residue is iodide of potassium, recogniz-
able by the tests before described (p. 280.) From the protiodide of
mercury it is distinguished by its colour and its solubility in a solution
chloride of sodium. The effects of heat on it, and its solubility in
iodide of potassium, are other characters which serve to recognise it.

**Composition.**—Its composition is as follows:

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<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
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<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>44.5</td>
</tr>
<tr>
<td>Iodine</td>
<td>2</td>
<td>252</td>
<td>55.5</td>
</tr>
<tr>
<td><strong>Biniodide of Mercury</strong></td>
<td><strong>1</strong></td>
<td><strong>454</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

**Purity.**—The presence of bisulphuret of mercury in it may be recog-
nised by fusion with caustic potash in a glass tube, by which a mixture
of bisulphuret and iodide of potassium is obtained: the existence of sul-
fur may be proved by the evolution of hydro sulphuric acid on the addi-
tion of a mineral acid.

**Physiological Effects.** (a.) *On animals.*—A scrupule killed a rabbit
in twenty-four hours: the stomach was found preternaturally reddened.
In grains, dissolved in a solution of iodide of potassium, and given to
a dog, caused vomiting, pain, tenesmus, and depression: in four or five
hours the animal was well (Cogswell, *Essay on Iodine*, p. 164). Maillet
(Journ. de Chim. Méd. iii. 543, 2 de Série) has also made some experi-
ments with it.

(b.) *On man.*—It is a powerful irritant and caustic. It is nearly as
powerful as the bichloride of mercury; indeed, Rayer (*Treatise on Skin
Diseases*, by Dr. Willis, p. 79) considers it more active than the latter.
Applied to ulcers, in the form of ointment, I have known it cause excru-
tiating pain. Left in contact with the skin for a while, it induces, says
Rayer, a most intense erysipelas-like inflammation. When administered
internally, it must be done with great caution. Like other mercurial
compounds, its repeated use causes salivation.

**Uses.**—It has been employed in the same cases (*i.e.* syphilis and
syphilis) as the protiodide of mercury, than which it is much more ener-
die. Breschet (O'Shaunessy's *Transl. of Lugol's Essays*, p. 204)
plied it, in the form of ointment, with great success in a case of obstri-
cation ulceration (thought to have been carcinomatous) of the angle of the
mouth. In the form of a dilute and thin ointment (composed of biniodide
of mercury, gr. ii.; cerate, gr. ii.; and almond oil, gr. i.) it has been used in
cases of the cornea (Gracé and Walther's *Journ. f. Chir.* Bd. 13). In
obstinate ophthalmia tarsi, with thickening of the meibomian glands, it has also been successfully employed.

**Administration.**—It should be given in doses of one-sixteenth of a grain, gradually increased to one-fourth of a grain. It may be exhibited in the form of pills, or dissolved in alcohol or ether.

**Unguentum Hydrargyri Biniodidi**, Ph. L. (biniodide of mercury, \( \frac{1}{2} \); white wax, \( \frac{3}{2} \); lard, \( \frac{3}{2} \) y. M.)

*Hydrargyri Bisulphuretum.*—*Bisulphuret of Mercury.*

**History.**—It is mentioned in the Old Testament (Jerem. xxii. 14). Theophrastus (De Lapidibus) says, that *cinnabar* (κόκκαλον) was accidentally discovered, by Callius, about ninety years before the magistracy of Praxibulus, of Athens—that is, 494 years before Christ. Geiger (Handb. d. Pharm., by Liebig) found it in the colouring matter of the old Egyptian tombs. It was formerly called *minium*. It is commonly termed *red sulphuret of mercury*; and, when in powder, *vermilion*.

**Natural History.**—The principal repositories of native *cinnabar* (*cinnabaris nativa*) are Idria, in Carniola, and Ahmadon, in Spain. It occurs both massive and crystalized; the primary form of its crystals being the acute rhombohedron.

**Preparation.**—Artificial *cinnabar* (*cinnabaris factitia*) is prepared by mixing two pounds of mercury, with five ounces of melted sulphur, in an iron pot over a fire; and, as soon as the mass begins to swell, it is to be removed from the fire, and covered, to prevent inflammation. When large quantities of sulphur and mercury are heated together, a slight explosion and flame are produced. When cold, it is rubbed to powder and sublimed in earthen pots (Ann. Chim. iv.; Aikin’s Dictionary of Chemistry).

In this process the heat enables the mercury and sulphur to combine, and form the bisulphuret.

**Properties.**—Artificial *cinnabar* has, in the mass, a dark reddish brown crystalline appearance; but, when reduced to a fine powder, is of a beautiful scarlet-red colour, and is then termed *vermilion*. It is tasteless, odourless, insoluble in water or alcohol, and unalterable in the air. It is fusible and volatile. It burns in the air with a blue flame, the sulphur uniting with oxygen to form sulphurous acid, while the mercury is dissipated in a vaporous form.

**Characteristics.**—Heated in a glass tube, with potash, it evolves mercurial vapour, which condenses into liquid globules of this metal. The residue, which is sulphuret of potassium, gives out hydrosulphuric acid on the addition of hydrochloric acid. The colour of *cinnabar* deepens under the influence of heat.

**Composition.**—Its composition is as follows:

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<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>86·32</td>
<td>86·21</td>
<td>86·29</td>
</tr>
<tr>
<td>Sulphur</td>
<td>2</td>
<td>32</td>
<td>13·67</td>
<td>13·79</td>
<td>13·71</td>
</tr>
<tr>
<td>Bisulphuret of Mercury</td>
<td>1</td>
<td>234</td>
<td>99·99</td>
<td>100·00</td>
<td>100·00</td>
</tr>
</tbody>
</table>

**Purity.**—Pure *cinnabar* is totally evaporated by heat, and is insoluble in nitric or hydrochloric acid. If *minium* or red lead be intermixed, we may recognise it by boiling in acetic acid, by which acetate of lead is
BISULPHURET OF MERCURY.

485

secured in solution: this forms a black precipitate with hydrosulphuric acid, white with the sulphates, and yellow with iodide of potassium. Sulphur, or sulphuret of arsenic, may be detected by boiling the suspected cinnabar in solution of caustic potash, supersaturating with nitric acid, and passing a current of hydrosulphuric acid through it, by which yellow precipitate (orpiment or sesquisulphuret of arsenic) is obtained. Earthy impurities are not volatile.

PHYSIOLOGICAL EFFECTS.—According to Orfila (Archiv. Gén. de Méd. 330), pure cinnabar is inert; for he found no effects were produced in dogs, by half an ounce, when either applied to wounds, or taken into the stomach. These results being opposite to those obtained by Smith (Treat. on Poisons, 3d. ed. 395), it has been presumed that the latter must have employed an impure sulphuret.

The vapour obtained by heating cinnabar in the air is poisonous; but it is not in opposition to Orfila's experiments, since this vapour is not sulphuret of mercury, but a mixture of the vapour of mercury (either the metallic or oxidized state) and of sulphurous acid gas. Schenkius (Observ. L. vii.) has related the case of a young man who died from the inhaling of this vapour; and Hill (Edinb. Med. Essays, iv.) saw cough, violent diathesis, diarrhoea, &c. produced by its inhalation.

USES.—Cinnabar is used merely as a fumigating agent, in venereal diseases of the nose and throat. The method of using it is this:—out half a drachm is placed on a heated iron, and the fumes inhaled, as they arise. In the shops, a copper apparatus, with iron heater, is sold for this purpose. In the absence of this, the bisulphuret is to be placed in a hot iron shovel, and the vapour inhaled by the patient through a funnel. The irritating nature of the sulphurous vapour usually excites coughing, and is injurious in persons disposed to phthisis. Hence the use of mercury is to be preferred for fumigating.

ADMINISTRATION.—When employed internally, cinnabar has been given in doses of from ten grains to half a drachm. For the purpose of fumigation, half a drachm may be employed.

hydrargyri Bisulphuretum cum Sulphure.—Bisulphuret of Mercury with Sulphur.

HISTORY.—It is stated that the Chinese used this remedy long before it was known to Europeans. Harris, in 1689, first taught the method of preparing it by trituration. Its most common name is Aethiops mineralis; it is also called black sulphuret of mercury (hydrargyri sulphuretum crassum, Ph. Dub., Ed. and U. S.) or sulphuret of mercury with sulphur (hydrargyri sulphuretum cum sulphure, Ph. Lond.)

PREPARATION.—Equal weights of mercury and sulphur are rubbed together until globules are no longer visible. In this process part of the sulphur enters into chemical combination with the mercury, to form the sulphuret, which is mechanically mixed with the remaining sulphur.

PROPERTIES.—It is a heavy, black, tasteless, odourless powder, insoluble in water. When heated it fuses, and is completely dissipated.

CHARACTERISTICS.—By boiling in caustic potash liquor we obtain a solution of sulphuret of potassium (vide p. 288). The residue is black, and possesses all the chemical characteristics of cinnabar (vide p. 484); but as being insoluble in nitric acid, volatile, &c.
**Composition.**—If this compound be, as Mr. Brande (Man. of Pharm. 3d ed. 329) supposes, a mixture of bisulphuret of mercury and sulphur, the proportions must be—

<table>
<thead>
<tr>
<th>Substance</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisulphuret of Mercury</td>
<td>58</td>
</tr>
<tr>
<td>Sulphur</td>
<td>42</td>
</tr>
<tr>
<td>Hydargyri Sulphuretum cum Sulphure, Ph. Lond.</td>
<td>100</td>
</tr>
</tbody>
</table>

**Purity.**—Free mercury may be detected by its communicating a white stain to gold. Charcoal may be detected by its not volatilizing by heat. Animal charcoal, by this character, as well as by the presence of phosphate of lime in the residue (vide p. 359). Sesquisulphuret of antimony may be recognised by boiling in hydrochloric acid, and applying the before-mentioned (p. 400) tests for sesquichloride of antimony.

**Physiological Effects.**—According to the experiments of Orfila, this preparation, like the last, possesses little or no activity. The late Dr. Duncan (Edinb. Dispensatory) also tells us, that he has given it in doses of several drachms, for a considerable length of time, with scarcely any effect. It is commonly regarded as alterative.

**Uses.**—It has been used in glandular diseases, especially of children; and also in cutaneous diseases.

**Administration.**—The dose for adults is from 5 to 30 grains.

*Hydrargyri Bicyanidum.*—*Bicyanide of Mercury.*

**History.**—This salt was discovered by Scheele. Its real nature was first pointed out by Gay-Lussac in 1815. It has been known by various appellations, as Prussian mercury (hydrargyrum borussicum), prussiate, hydrocyanate, cyanuret, or cyanodide of mercury (hydrargyri prussias, hydrocyanas, cyanuretum, seu cyanodidum).

**Preparation.**—Two methods have been adopted for the preparation of it.

(a.) *Proust's process.*—In the Pharmacopœia, eight ounces of ferrosesquicyanide of iron, or Prussian blue (ferri perecyanidum, Ph. L.) are directed to be boiled with ten ounces of binoxide of mercury and four pints of water. The mixture is to be strained and evaporated, so that it may crystallize. The undissolved residuum is to be washed with boiling distilled water, filtered, and evaporated, so as to yield crystals.

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 eq. Cyan. 78</td>
<td>3 eq. Iron. 84</td>
</tr>
<tr>
<td>4 eq. Sesquicy. Iron... 268</td>
<td>6 eq. Cyan. 156</td>
</tr>
<tr>
<td>4 eq. Iron... 112</td>
<td>4 eq. Mer. 909</td>
</tr>
<tr>
<td>4½ eq. Binoxide of Mercury .......... 981</td>
<td>3 eq. Oxide Iron... 106</td>
</tr>
<tr>
<td>6 eq. Oxyg. 48</td>
<td>4 eq. Sesquioxide of Iron... 160</td>
</tr>
</tbody>
</table>

The awkwardness of the use of half an equivalent may be easily obviated by doubling all the above numbers; but several reasons have induced me to retain it in the above diagram.

(b.) *Winckler's process.*—Bicyanide of mercury may be obtained more economically, and purer, by adding as much finely-pulverized binoxide of mercury to hydrocyanic acid (obtained by distilling ferrocyamide of potassium with diluted sulphuric acid, vide p. 236) as will saturate it.
er, and crystallize. In this process double decomposition takes place, resulting products being water and bicyanide of mercury.

**REAGENTS.**

<table>
<thead>
<tr>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocyanic Acid &amp; 12 eq. Hydrogen &amp; 2</td>
</tr>
<tr>
<td>Binoxide Mercury &amp; 12 eq. Oxygen &amp; 16</td>
</tr>
</tbody>
</table>

**RESULTS.**

<table>
<thead>
<tr>
<th>Composition</th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Gay-Lussac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
<td>79.52</td>
<td>79.91</td>
</tr>
<tr>
<td>Cyanogen</td>
<td>2</td>
<td>52</td>
<td>20.47</td>
<td>20.09</td>
</tr>
<tr>
<td>Bicyanide of mercury</td>
<td>1</td>
<td>254</td>
<td>99.99</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**PROPERTIES.**—The primary form of the crystals of this salt is the right square prism. The crystals are heavy, white, colourless, transparent or aque, inodorous, and have a strong metallic taste. They are soluble in water, both hot and cold, and very little, if at all so, in alcohol.

**CHARACTERISTICS.**—Perfectly dry bicyanide of mercury when heated dissolves metallic mercury and cyanogen gas. The latter is known by the bluish or bluish red colour of its flame. Heated with hydrochloric acid evolves hydrocyanic acid. It is not decomposed by nitric acid or the earthy solutions. Its solution throws down a black precipitate with hydrosulphuric acid, and pearly crystalline plates (hydrargyro-iodo-cyanide of potassium) with a concentrated solution of iodide of potassium (**vide** 239).

**COMPOSITION.**—Its composition is as follows:

<table>
<thead>
<tr>
<th>Composition</th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Gay-Lussac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>1</td>
<td>202</td>
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</tr>
<tr>
<td>Bicyanide of mercury</td>
<td>1</td>
<td>254</td>
<td>99.99</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**PURITY.**—When prepared from ferrosesquicyanide of iron (Prussian blue) the crystals are usually yellowish, from the presence of some oxide of iron.

**PHYSIOLOGICAL EFFECTS. (a.) On vegetables.**—It acts on plants like chlorid of mercury (Geppert, in Decand. Phys. Vég. 1334).

**(b.) On animals.**—Coulon (Traité sur l’Acide Prussique, quoted by Abner, Wirk d. Arzneim. iii. 30) found that it acted on dogs, cats, arrows, frogs, snails, &c. like hydrocyanic acid. After death, inflammation of the stomach was observed. Ollivier d’Angers (Journ. de Chim. &d. i. 269) tried its effects on dogs. Seven grains, dissolved in water, fed a small dog in ten minutes, under attempts to vomit, general convulsions, and exhaustion, manifested alternately; respiration and circulation at first accelerated, afterwards diminished. Similar effects were produced by applying the salt to the cellular tissue; or injecting it into veins. Tiedemann and Gmelin (Versuche u. d. Wege auf welch. Abb. aus d. Magen u. Darmk. ins Blut gelang.) detected mercury in the nod of the splenic vein of a horse to whom the bicyanide had been administered.

**(c.) On man.**—Taken in small doses, it very readily excites nausea and vomiting. Parent (Journ. de Chim. Méd. viii. 473) says it does not produce the epigastric pain which the bichlorid of mercury readily occasions. Continued use causes salivation. In one case, one-eighth of a grain twice a day caused ptyalism in three days (Neumann, in Dierbach’s Med. Entd. i. 483, 1828). Mendaga (Decades Medicopurguticas y Farmaceuticas, vi. 319, in Richter’s Ausführen Arzneim. v. 27) says it acts directly on the skin and bones, and hence it sometimes by speedily allays the pain of and disperses nodes.
In large doses, especially in very susceptible persons, it affects the nervous system, and causes fainting, anxiety, and cramps. Twenty-three and a half grains in one instance (Journ. de Chim. Méd. i. 210) caused death in nine days. The most remarkable symptoms were, obstinate vomiting; mercurial ulceration of the mouth and abundant ptalism; contractions of the heart, which at first were very strong, but became successively slower and more feeble; the abdomen was yielding, and not tender, notwithstanding the constant tenesmus; suppression of urine; semi-erection of the penis, and ecchymosis of this organ, as well as of the scrotum; and, ultimately, convulsive movements.

Uses. (a.) Medicinal.—It has been employed as an antivenereal medicine, and was first used as such by Brera (Richter, op. cit.) Parent (Journ. de Chim. Méd. viii. 473) administered it as a substitute for the bichloride of mercury, over which it has several advantages. Thus, being more soluble, it ought to be more readily absorbed; it does not give rise to epigastric pain; and, lastly, it is not so readily decomposed; for alkalies, several salts, and many solutions of organic matters, which decompose corrosive sublimate, have no effect on it. It may be applied in the form of aqueous solution or ointment to venereal sores.

It has been employed in induration of the liver, in some chronic skin diseases, in obstinate headache, and in other maladies, as an antiphlogistic.

(b.) Pharmaceutical.—Its principal use in this country is as a source of hydrocyanic acid (vide p. 237) and of cyanogen gas.

Administration.—Internally it may be employed in doses of one-sixteenth of a grain gradually increased to one-half of a grain. It may be administered in the form of pills (made with crumb of bread) or alcoholic solution. It will be frequently advisable to conjoin opium, to prevent nausea or vomiting. When used as a gargle or wash, we may employ ten grains to a pint of water. An ointment may be prepared of ten or twelve grains to an ounce of lard.

Antidote.—I am unacquainted with any antidote for it. Albumen does not decompose it. Perhaps ammonia might be found serviceable, to diminish the effect on the nervous system. Opium relieves the vomiting. Our principal object must be to remove the poison from the stomach, which is to be effected by the stomach-pump, emetics, tickling the throat, &c.

Unguen'tum Hydrar'gyri Nitra'tis.—Oint'ment of Ni'trate of Mer'cury.

History.—This ointment is sometimes termed citrine ointment (un-guentum citrinum). Another name for it is mercurial balsam.

Preparation.—It is prepared by dissolving mercury in nitric acid and adding the solution to some kind of fatty matter. The relative quantities of acid and metal employed, as well as the nature of the fatty matter used, are various in different formulæ. The following are the proportions directed to be employed in the British and United States Pharmacopoeias.
The London Pharmacopoeia directs the solution to be mixed while with the lard and oil melted together. The Edinburgh and United States Pharmacopoeias order the solution to be added to the mixture of oil and oil when it begins to stiffen.

The theory of the process is as follows:—By the mutual action of mercury and strong nitric acid, a nitrate of the binoxide, as well as of the protoxide of mercury, is formed, while binoxide of nitrogen is liberated. Part of the latter escapes, and, combining with atmospheric oxygen, forms nitrous acid; the remainder reacts on the free nitric acid, and forms, with it hyponitrous or nitrous acid. The liquor then is a mixture of nitric acid in excess, probably of nitrous acid, of the nitrate of hyponitrite of the binoxide of mercury, and nitrate of the protoxide of mercury.

When this solution is added to the fatty matter (lard and olive oil), the nitrous acid, or the hyponitrous acid which it contains, converts the olive into a more consistent and less fusible fatty body, which Boudet (Ann. de Chim. Méd. viii. 641) calls elaidine, (from ἐλάαιον, ἐλαῖον, an oil tree.) The stearine and elain of the lard also acquire greater consistency in consequence of undergoing an analogous change. There is also yellow colouring matter produced, and which may be separated by alcohol. By the saponification of a portion of the elaidine a small quantity of mercurial soap (elaidate of mercury) is produced. The nitrous acid of the hyponitrite is capable of producing the same effect as the free acid.

Boudet is of opinion that these changes are effected by the physical influence of the nitrous acid, for he asserts that the decomposition of the latter is not essential to the formation of the elaidine. In this I suspect he is in error.

By keeping, this ointment is apt to become hard, pulverizable, and thereby unfit for use. This depends principally on the change which the olive oil suffers. Hence in the United States Pharmacopoeia neatsfoot has been substituted for olive oil. The editors of the United States Dispensatory observe, that they had in their "possession, upwards of four months, a pot of ointment made according to the process of the Pharmacopoeia, and though it had, at the end of this time, partially assumed a greenish colour, it preserved a uniform, soft, unctuous, consistence."

The fatty bodies exercise a deoxidizing influence on the acids (free or combined) of the solution, and which is supposed to be independent of the formation of elaidine; and, in consequence of this, nitrogen or oxides of nitrogen is evolved. They also deoxidize the oxides of mercury, reducing the binoxide to the state of protoxide, and, in time, inverting the protoxide into metallic mercury; which, being in a finely divided state, gives to the mass a greyish colour. This latter change is favored by two facts—first, the change of colour which the ointment undergoes; and secondly, by digesting old citrine ointment in ether, the fatty matters are dissolved, leaving behind metallic mercury.

It is to prevent this change that Guibourt (Pharm. Raisonnée, ii. 146)
and Dr. Duncan (Edinb. Dispensat.) direct more nitric acid to be used than is contained in the official formulæ.

Properties.—When fresh prepared this ointment has a fine golden yellow colour, a butyraceous consistence, and a remarkable nitrous odour. It is very apt to become grey when mixed with other ointments, in consequence of their deoxidizing powers. It should be spread with wooden or ivory spatulas.

Composition.—When fresh prepared this compound contains the following substances:—

Elaidine.
Yellow matter soluble in alcohol.
Elaidate of mercury (mercurial soap.)
Nitrate of mercury.

Elaidine is a white saponifiable fat, fusible at 97° F. very soluble in ether, but requiring 200 times its weight of boiling alcohol to dissolve it. When mixed with potash or soda it is converted into glycerin and elaïdic acid.

Physiological Effects.—It is an irritant and slight caustic. When it has undergone decomposition by keeping, it irritates ulcers exceedingly, and even excites slight erysipelas and inflammation.

Uses.—We employ it as a stimulant and alterative in chronic diseases of the skin, more particularly those affecting the hairy scalp, as the different forms of porrigo, in which it is exceedingly efficacious. It is also used as a dressing to ulcers—to stimulate and cleanse them—as in foul syphilitic sores and phagedaenic ulcers. Lastly, it is employed in ophthalmic diseases—more particularly ophthalmia tarsi, or psorophthal-mia, in which it is applied (mixed with its own weight of almond oil) by means of a camel’s-hair pencil to the lids, frequently with such advantage that some have regarded it a specific in this complaint.

Hydrargyri Acetas.—Acetate of Mercury.

History.—This compound was known to Lefebure in the 17th century.

Preparation.—In the Dublin Pharmacopoeia the directions for procuring it are the following:—Add eleven parts of diluted nitric acid to nine parts of mercury, and when the effervescence has ceased let the mixture be digested that the metal may be dissolved. Add this to a boiling solution of nine parts of acetate of potash in a hundred of distilled water acidulated with vinegar; filter through a double hair-cloth, and let it cool, that crystals may form. Wash them with cold distilled water, and dry on paper with a gentle heat. In the Edinburgh Pharmacopoeia a larger quantity of nitric acid is used and the vinegar omitted, as well as the directions for filtering through linen.

By the mutual action of diluted nitric acid and mercury we obtain a protonitrate of mercury (vide p. 463.) When this is mixed with acetate of potash double decomposition takes place: nitrate of potash and protoacetate of mercury being formed. To prevent precipitation of the yellow subnitrate of mercury, excess of acid (acetic, Ph. Dub., nitric, Ph. Ed.) should be employed: and by filtering, while hot, any which may be formed would be separated before the acetate has deposited.

Properties.—This salt occurs in white, micaceous, flexible scales, which are inodorous, but have an acrid taste. It blackens by light. When heated it is resolved into carbonic acid, acetic acid, and mercury.
as very slightly soluble only in water, requiring 300 times its weight of
is liquid to dissolve it, according to Dumas. It is insoluble in cold
ahl : boiling alcohol abstracts part of its acid.
CHARACTERISTICS.—Its appearance, its slight solubility in water, and
action of heat on it. Heated with sulphuric acid the vapour of acetic
id is evolved. The fixed alkalies precipitate the black oxide of mer-
Chloride of sodium forms calomel with it.
COMPOSITION.—It has the following composition:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protic Acid of Mercury</td>
<td>1</td>
<td>200</td>
<td>80.46</td>
<td>80.66</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>1</td>
<td>51</td>
<td>19.54</td>
<td>19.34</td>
</tr>
<tr>
<td>Acetate of Mercury</td>
<td>1</td>
<td>261</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

PHYSIOLOGICAL EFFECTS.—It is one of the mild mercurial preparations.

on the reports of Guarin, Colombier, and Vogler (Wibuer, Wirk. d.
Zneim. iii. 67) it appears to have acted in some cases with great
ience, and to have occasioned violent vomiting, purging, abdominal
in, bloody evacuations, &c. These effects probably arose from the
ence of some acetate of the binoxide of mercury.

USES.—It was introduced into practice in consequence of being
posed to be the active ingredient of Keyser’s antivenereal pills. But
obiect has subsequently ascertained that Keyser employed the acetate
the binoxide (Dumas, Traité de Chimie, v. 178). It is occasionally
ed in syphilitic affections.

ADMINISTRATION.—The dose of it is from one to five grains. A
ution composed of one grain of the acetate dissolved in an ounce of
ter, may be used as a wash. An ointment is prepared by dissolvingo or three scruples in an ounce of olive oil.

_Hydrargyri Subsulphas Flavus._—Yellow Subsulphate of Mercury.

HISTORY. — This compound was known to Croll in the sixteenth
ntury. It has been termed Turpeth (or Turbith) mineral (Turpethum
nerale), from its resemblance in colour to the root of the _Ipomoea
rperthum._

PREPARATION.—It is prepared by adding one part of persulphate of
cury (the mode of preparing which has been described at p. 464) to
y parts of warm or boiling water. A supersulphate of mercury is
med in solution, and a subsulphate precipitates.

PROPERTIES.—It is a heavy, lemon-yellow, inodorous powder, having
acid taste. It requires 2000 parts of water at 60°, or 600 parts at
°, to dissolve it.

CHARACTERISTICS.—When heated in a tube, sulphurous acid is
olved, and globules of mercury sublimed. Boiled with caustic potash
oda, the red binoxide precipitates, and a solution of sulphate of
ash is obtained, known to be a sulphate by chloride of barium (vide
265).

COMPOSITION.—Its composition is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binoxide of Mercury</td>
<td>1</td>
<td>218</td>
<td>84.5</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>15.5</td>
</tr>
<tr>
<td>Subsulphate of Mercury</td>
<td>1</td>
<td>258</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Physiological Effects.—In small quantities it occasions nausea, vomiting, and ptalmism. Taken into the nostrils it excites sneezing, and sometimes salivation. Stenzel (Wibmer, *Wirk. d. Arzneim. iiii. 60*) mentions a fatal case from its internal use.

Uses.—It is sometimes used as an emetic in cases of swelled testicle, to promote absorption by its nauseating and emetic action (*Observe. on the Dublin Pharmacopoeia*). It was formerly given at the commencement of a mercurial course. As an erthrine it has been administered in chronic ophthalmia and affections of the brain, as incipient hydrocephalus. As an alterative it has been given in the scaly diseases (*lepra* and *psoriasis*).

Administration.—As an alterative, the dose should not exceed half a grain, or at most a grain. As an emetic it is given to the extent of five grains; in which dose it causes violent vomiting. As an erthrine, a grain should be mixed with four or five of some mild powder, as starch or liquorice powder. It is rarely given for any other purposes.

Order 21.—Copper and its Compounds.

*Cuprum.*—*Copper.*

History.—Cuprum, or copper, received its name κύπρος, from the island of Cyprus, where it was first discovered, or at least worked to any extent. It seems to have been known in the most remote ages of antiquity, for Moses (*Job, ch. xxviii.*) speaks of brass (an alloy of copper and zinc). The alchemists called it *Venus.*

Natural History.—It is found in both kingdoms of nature.

(a) *In the inorganized kingdom.*—Copper is found in the metallic or reguiline state, combined with oxygen, with sulphur, with selenium, with chlorine, or with oxygen, and an oxyacid (carbonic, arsenic, phosphoric, sulphuric, or silicic).

(b) *In the organized kingdom.*—It has been discovered in the ashes of most plants, as of stavesacre, rhatany, flax, nux vomica, hemlock, &c. Sarzeau has detected it in the blood of animals (*Ann. de Chim. xliiv. 334*).

Preparation.—The copper of commerce is usually prepared from copper pyrites or grey copper ore (both sulphurets). These are roasted and then smelted, by which coarse metal is procured. This is calcined and again smelted, by which we obtain fine metal, or, when cast in sand, blue metal. By re-roasting and smelting, coarse copper is produced. These processes, of roasting and smelting, effect the expulsion of the sulphur and the oxidizement of the iron. The copper thus produced is melted and exposed to the air, to drive off any volatile matters by which blistered copper is obtained. It is refined or toughened by melting it and stirring with a birchpole (*J. H. Vivian, Ann. of Philosophy* N.S. v. 113).

Properties.—It is a crystallizable, brilliant, red metal, crystallizable in regular octahedra and cubes, having a specific gravity of 8.96 to 8.89; malleable and ductile; it has a nauseous, styptic taste, and a peculiar and disagreeable smell. It fuses at 1996°F. (*Daniel*); at a higher temperature it may be volatilized. Its equivalent is 32. It is combustible. It is readily oxidated. Acid, alkaline, saline, and fatty bodies, when placed in contact with it in the air, promote its union with oxygen; and, by dissolving a portion of the newly-formed oxide, acquire poisonous properties.
CHARACTERISTICS.—Copper is easily recognized by its colour, by its communicating a green tinge to flame, and by dissolving it in nitric acid. The solution possesses the following properties: it is blue, or greenish blue; potash or soda occasions a blue precipitate of the hydrated oxide of copper; a small quantity of ammonia produces a similar bluish tinge, but an excess redissolves it, forming a deep blue fluid: ferrocyanide of potassium occasions a reddish brown precipitate the ferrocyanide of copper; the hydrosulphurets throw down the black sulphuret; and, lastly, a polished iron plate plunged into the fluid, becomes coated with metallic copper.

PHYSIOLOGICAL EFFECTS.—(a) Of metallic copper.—Metallic copper appears to produce no pernicious effects when taken internally, so long as it retains its metallic state, as many cases are recorded where coins of this metal have been swallowed and retained for a considerable time without any ill effects arising; and Drouard (Exper. et Observ. sur l'Empoisonnem. par l'Oxide de Cuivre, Paris, 1802) gave as much as an ounce of finely powdered copper to dogs of different ages and sizes, but none of them experienced any inconvenience. Notwithstanding these facts, however, various effects have been attributed to it. Thus, Cothenius (Voigtel, Arzneimittellehre) says, copper filings operate by stool, urine, and saliva; and the late Professor Barton (chapman's Elem. of Therap. ii. 457) was accustomed to relate an instance of a child, who, having swallowed a cent, continued for some time to discharge several pints of saliva. Lastly, Portal (Orfila, Toxicol. ii.) mentions a case in which copper filings, incorporated with crumb bread, acted powerfully on the system. I have no doubt but that the effects here mentioned arose from the oxidation of the metal by the acids of the alimentary canal.

(b) Of the Cupreous Compounds.—If the cupreous preparations be used in very small doses, they sometimes give relief in certain diseases (principally of the nervous system), without obviously disordering the actions; in other words, in these instances the only apparent effect is the modification observed in the morbid condition. These are the cases in which these preparations have been termed tonic, antispasmodic, or alterative, according to the nature of the disease; thus, in ague they have been termed tonic, in epilepsy antispasmodic, in dropsy alterative. The beneficial operation is presumed to be owing to some influence exerted by the remedy over the nervous system. The effects produced by the long-continued use of small doses of the preparations of copper have not been satisfactorily determined; they are said to be various actions of the nervous system (such as cramps or paralysis), alteration of the colour of the skin, chronic inflammation of the respiratory and digestive apparatus, slow fever, and wasting of the body. These symptoms constitute what has been termed slow, or chronic poisoning by copper. The smelters and workers in copper do not suffer from the vapour or emanation of this metal, as the workmen employed in the preparation of mercury, of arsenic, or of lead do, from the vapours of these metals; this, indeed, might be expected, when we consider how much more volatile the latter and their preparations are, than copper and its compounds. In larger, or full medicinal doses, these remedies act as emetics, exciting speedy vomiting, with less nausea than tartar emetic produces. In still larger quantities these bodies act as poisons, giving
rise to gastro-intestinal inflammation, and disordered the functions of the nervous system (especially the cerebro-spinal portion), constituting acute poisoning by copper. The usual symptoms are, a coppery taste, eructations, violent vomiting and purging, gripping pains, cramps in the legs and thighs, headache, giddiness, convulsions, and insensibility: jaundice is occasionally observed. In some cases the cerebro-spinal symptoms precede those which indicate inflammation of the alimentary canal. In experiments made on animals, it has been observed that death was sometimes produced without any marks of local irritation; the symptoms being those indicative of a disordered condition of the nervous system. By some toxicologists these preparations are ranked among the irritant poisons, though Buchner (Toxicologie), judging from Reiter's experiments, terms them astringent.

Drouard, and others, were of opinion that the preparations of copper do not become absorbed, but Lebkuehner (Christison, Treat. on Poisons, 3d ed. 483), has detected copper in the blood of the carotid artery of a cat, into whose bronchial tubes he had injected four grains of the ammoniacal sulphate; and Wibmer, (Wirk. d. Arzn. ii. 244), has found it in the liver of animals to whom he had given the acetate for several weeks.

Post-mortem appearances.— In animals killed rapidly by these poisons, no morbid appearances are found, in consequence of death being produced by their action on the nervous system; but when the death was slow, marks of gastro-intestinal inflammation, and occasionally indications of inflammation of the brain, have been observed.

Uses. (a.) Of metallic copper.—Copper filings, in doses of three or four grains, were formerly used in rheumatism, and also as an antidote against the effects of the bite of a mad dog.

(b.) Of the cupreous compounds.—These preparations are used both as external and as internal remedies; externally as stimulants, astringents, styptics, and caustics; internally, as emetics and tonics, or anti-spasmodics. The particular cases will be noticed when treating of the individual preparations.

Antidotes.—The chemical antidote for the cupreous preparation is albumen; hence, the whites of eggs, and in the absence of these, milk, or even wheaten flour, should be employed. Iron filings have been proposed by Navier, by Payen and Chevalier, and subsequently by Dumas and Milne Edwards. The iron decomposes the cupreous salt, and precipitates the copper in the metallic (and, therefore, in an inert) state. The ferrocyanide of potassium is also said to be a good antidote: a drachm or two of it may be taken with safety, for it is not so poisonous as was at one time imagined. Sugar was proposed by Marcelin Duval as an antidote; its efficacy, though denied by Orfila and Vogel, has been lately reasserted by Postel. The alkaline sulphures formerly used are worse than useless, since they are active poisons. The inflammatory symptoms are of course to be subdued by the usual means. (For further details on this subject consult Christison's Treat. on Poisons.)

Cu'pri Sul'phas.—Sul'phate of Cop'per.

History.—This substance was probably employed by Hippocrates (De ulceribus), under the name of χαλκίτις κρανίς (chalcitis caerulea), to promote the healing of ulcers. Pliny (Hist. Nat. xxxiv. 32.) also was
It is doubtless acquainted with it, though he seems to have confounded it with sulphate of iron. His chalcanthum cyprium was, perhaps, sulphate of copper. This salt has had various synonyms, such as blue vitriol (vitriolum caeruleum) Roman vitriol, blue copperas, blue stone, bisulphate of copper.

**Natural History.**—It occurs in copper mines (as those of Cornwall, \( \ldots \)) and is formed from sulphuret of copper by the joint agency of air and water. The cuprous solutions of copper mines are termed waters of cementation.

**Preparation.**—It may be prepared by evaporating the water found or issuing from, copper mines. It is also produced by roasting copper pyrites, lixiviating the residuum to dissolve the sulphate, and evaporating as to obtain crystals. In this process both the sulphur and the copper in the pyrites abstract oxygen from the air; and become, the one sulphuric acid, the other oxide of copper: these by their union constitute the sulphate of copper.

**Properties.**—This salt occurs in fine blue crystals, whose primary term is the doubly oblique prism. Its sp. gr. is 2·2. It has a styptic metallic taste, and reacts on litmus as an acid. By exposure to the air, it effloresces slightly, and becomes covered with a greenish white powder. When heated it loses its water of crystallization, and becomes white powder (pulvis sympatheticus.) By a very intense heat it is decomposed,—sulphurous acid and oxygen are evolved, and oxide of copper left. It dissolves in about 4 parts of water at 60°, and 2 parts of boiling water. It is insoluble in alcohol.

**Characteristics.**—Its characteristics are those of the sulphates (vide p. 265), and of the cupreous compounds (vide p. 493.)

**Composition.**—Its composition is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Thomson</th>
<th>Berzelius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide of Copper</td>
<td>1</td>
<td>40</td>
<td>32</td>
<td>32</td>
<td>32·13</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>32</td>
<td>32</td>
<td>31·57</td>
</tr>
<tr>
<td>Water</td>
<td>5</td>
<td>45</td>
<td>36</td>
<td>36</td>
<td>36·30</td>
</tr>
<tr>
<td>Crystallized Sulphate of Copper</td>
<td>1</td>
<td>125</td>
<td>100</td>
<td>100</td>
<td>100·00</td>
</tr>
</tbody>
</table>

**Impurity.**—The commercial sulphate of copper sometimes contains traces of sulphate of iron. It may be detected by excess of ammonia, which throws down the oxide of iron, but dissolves the oxide of copper.

**Physiological Effects.** (a.) On vegetables.—It is poisonous to plants Necandolle, Phys. Vég. 1333): hence its use in preventing dry rot (Tulbulus lachrymans), by soaking timber in it, according to Mr. Bargery's patent; and in destroying or preventing the smut (Uredo metum), or bunt (U. caries), in corn, by immersing the grain in a weak solution of it: the solution is not made sufficiently strong to injure the seed.

(b.) On animals.—This salt operates as a poison to animals. Six grains killed a dog in half an hour, without producing any appearance of inflammation (Drouard). Applied to a wound it destroyed the animal twenty-two hours, and the body was every where in a healthy state (U. Duncan, in Christison on Poisons, 432). Orfila (Tox. Gén.) also found that it proved fatal in a few hours when applied to wounds. The only symptoms mentioned are dulness, loss of appetite, and sometimes vomiting. Inflammation of the mucous membrane of the stomach and intestine was found after death.
(c.) On man.—In very small doses it has no sensible operation on the body, though it occasionally ameliorates certain diseases, such as epilepsy and ague: in these cases it has been denominated an antispasmodic and tonic. The local action on the alimentary tube is that of an astringent. Dr. Elliotson (Lond. Med. Gaz. xii. 557) has known a patient to take it for three years, for a particular kind of diarrhoea, without any constitutional effect. In larger doses it is a safe and useful emetic, acting very speedily, and without exciting any great disorder of the general system. In excessive doses it becomes a poison, producing inflammation of the alimentary canal, and disordering the functions of the nervous system, as noticed when describing the action of the cupreous preparations generally. In a case mentioned by Dr. Percival (Trans. Lond. Coll. Phys. iii. 88) two drachms proved fatal: the patient was violently convulsed. In a more recent case (Lond. Med. Gaz. xviii. 624 and 742) there were vomiting and insensibility, but no convulsions or purging: the child died in four hours.

Its topical action is stimulant, astringent, styptic, and caustic. Its causticity depends on its union, either as a neutral or basic salt, with one or more of the constituents of the tissues. Thus it combines with albumen to form a pale bluish green compound, which produces with caustic potash a violet-coloured solution (Dr. C. G. Mitscherlich, Brit. Ann. of Med. i. 751 and 817, and ii. 51).

Uses.—Where speedy vomiting without much nausea is required, as in cases of narcotic poisoning, sulphate of copper is a tolerably sure and valuable emetic. It has also been used, with success, to provoke vomiting in croup, and thereby to promote the expulsion of the false membrane, (Brit. and For. Med. Rev. i. 568.)

As an astringent it has been used in chronic diarrhoea and dysentery by Dr. Elliotson (Lond. Med. Gaz. viii. 378, and xii. 557; also Med. Chir. Trans. xiii. 451), who found it succeed where the ordinary vegetable astringents fail. It should be given in doses of from half a grain to two grains twice or thrice a day, in combination with opium. It is also used as an astringent to check excessive secretion from the bronchial and urino-genital mucous membranes. Dr. Wright (Lond. Med. Journ. i. and x.) found it serviceable in dropsy.

As a tonic or antispasmodic it has been given in intermittent diseases, as the ague; and in some maladies of the nervous system (epilepsy and chorea). In epilepsy it has recently been strongly recommended by Dr. F. Hawkins (Lond. Med. Gaz. viii. 183).

As a topical agent, it is often employed in substance as an application to ulcers, either for the purpose of repressing excessive soft and spongy granulations, commonly denominated "proud flesh," or of hastening the process of cicatrization; and for either of these purposes it is one of the best agents we can employ. Solutions of it are frequently applied to mucous membranes, to diminish excessive secretion: thus to the conjunctiva, in chronic ophthalmia, and to the mucous lining of the vagina or urethra, in discharges from these parts. In superficial ulcerations of the mucous membranes (especially of the mouth), one or two applications of the sulphate of copper, in substance, are generally sufficient to heal them.

As a styptic a solution of this salt is sometimes used to repress hemorrhages from a number of small vessels. Rademacher applied with good effect brandy impregnated with sulphate of copper in a case of alopecia,
baldness, which occurred in a young man; but it failed in the hands of Dr. T. J. Todd (Cyclopaedia of Pract. Med. i. 52.)

Administration.—The dose of it, as an emetic, is from three or four grains to fifteen; as an astringent, or tonic, from a quarter of a grain to one or two grains. Solutions used for external purposes vary considerably in their strength in different cases, but usually from one or two grains to eight or twelve, dissolved in an ounce of water.

Antidotes.—Vide Cuprum.

Solutio Sulphatis Cupri Composita. Ph. Ed. (sulphate of copper; alum, 3ij.; water, lb. ij.; sulphuric acid, 3is.) Boil until the sulphates are dissolved; then filter, and add the acid.)—It is employed as a styptic, to arrest haemorrhage; and, when diluted, in the purulent ophthalmia of children.

Ammominie Cu’pro-Sulphas.—Cu’pro-Sulphate of Ammonia.

History.—Boerhaave was acquainted with an ammoniacal solution of copper. In 1757 Weissman gave imperfect directions for its preparation. 1799 Acoluth published a better process. Dr. Cullen introduced this substance into practice in this country. It is frequently called ammoniated copper (cuprum ammoniatum, Ph. Dubl. and U. S.) or ammonyx of copper (cupri ammoniaretum, Ph. Ed.) In the London Pharmacopœia it is termed ammonio-sulphate of copper (cupri ammonio-sulphas).

Preparation.—In all the British Pharmacopœias, this compound is directed to be prepared by rubbing an ounce of sulphate of copper with an ounce and a half of sesquicarbonate of ammonia until carbonic acid fumes to evolve.

The theory of the process is imperfectly understood. The proportions of ingredients employed are about two equivalents of sulphate and three and one-fifth equivalents of sesquicarbonate. When rubbed together, these salts give out part of their water of crystallization, by which the mass becomes moist; and, at the same time, a portion of carbonic acid escapes, producing the effervescence alluded to; and the compound becomes of a deep azure-blue colour. This colour is probably owing to cuprure of ammonia; for oxide of copper with caustic ammonia forms a similarly-coloured liquid. If this notion be correct, decomposition may be thus explained:—Two equivalents or 118 parts of hydrated sesquicarbonate of ammonia react on one equivalent or 125 parts of crystallized sulphate of copper, and produce one equivalent or 1 parts of cuprure of ammonia, one equivalent or 57 parts of sulphate of ammonia, seven equivalents or 63 parts of water, and three equivalents of 66 parts of carbonic acid. The cuprate and sulphate of ammonia with one equivalent of water represent the crystallized cupro-sulphate of ammonia (cuprum ammoniacale of some authors).

Reagents.

<table>
<thead>
<tr>
<th>3 eq. Carb. Acid 66</th>
<th>3 eq. Carb. Acid 66</th>
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<tbody>
<tr>
<td>Hydratd. Seque.</td>
<td>3 eq. Water 54</td>
</tr>
<tr>
<td>Hydr. Ammon. 118</td>
<td>6 eq. Water 54</td>
</tr>
<tr>
<td>12 eq. Water 18</td>
<td>1 eq. Sulph. of Ammonia 57</td>
</tr>
<tr>
<td>1 eq. Ammonia 17</td>
<td>1 eq. Sulphate of Ammonia 57</td>
</tr>
<tr>
<td>1 eq. Ammonia 17</td>
<td>1 eq. Water 54</td>
</tr>
<tr>
<td>Crystall. Sulph.</td>
<td>1 eq. Cryst. Cupro-</td>
</tr>
<tr>
<td>Copper 1 25</td>
<td>Sulph. of Ammonia 123</td>
</tr>
<tr>
<td>5 eq. Water 45</td>
<td>1 eq. Oxid Copper 46</td>
</tr>
<tr>
<td>1 eq. Sulph. Acid 46</td>
<td>1 eq. Cuprure of Ammonia 57</td>
</tr>
</tbody>
</table>

Properties.—It has a deep azure-blue colour, a styptic metallic taste, and an ammoniacal odour. It reacts on vegetable colours as an alkali: K K
thus it reddens turmeric, and restores the blue colour of litmus, which has been reddened by an acid. By exposure to the air, ammonia is evolved, and a green powder is left, composed of sulphate of ammonia and carbonate of copper. To prevent this, therefore, it should be preserved in a well-stoppered bottle. It is soluble in water; but unless excess of sesquicarbonate of ammonia be present, the solution, when much diluted, lets fall a subsulphate of copper.

Characteristics.—Dissolved in water it forms a green precipitate (arsenite of copper) with a solution of arsenious acid. When heated, all its constituents are dissipated, save the oxide of copper. Boiled with caustic potash a solution of sulphate of potash is obtained, the hydrated oxide of copper is thrown down, and ammonia is disengaged. Sulphuric acid may be recognised in the solution by the barytic salts.

Composition.—The essential part of this compound is the eupro- sulphate of ammonia. This, in the crystalline state, has the following composition:

<table>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide of Copper</td>
<td>1</td>
<td>40</td>
<td>32-52</td>
<td>34'00</td>
<td>33'01</td>
</tr>
<tr>
<td>Ammonia</td>
<td>2</td>
<td>34</td>
<td>27'64</td>
<td>26'40</td>
<td>21'40</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>32'52</td>
<td>32'25</td>
<td>31'75</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>9</td>
<td>7'32</td>
<td>7'35</td>
<td>13'58</td>
</tr>
</tbody>
</table>

Cupro-sulphate of Ammonia 1... 123... 100'00... 100'00... 99'338

The cupri ammonio-sulphas, Ph. L., usually contains some undecomposed sesquicarbonate (bicarbonate?) of ammonia, and probably some sulphate (sub.sulphate?) of copper.

Physiological Effects.—Its action is, for the most part, similar to sulphate of copper. Wibmer (Wirk. d. Arzneim. ii. 256) examined its effects on horses and dogs. Four grains dissolved in water, and injected into the veins, killed a dog. The respiration and circulation were quickened by it. In some cases vomiting and purging were produced; weakness, tremblings, and paralysis, indicated its action on the nervous system. Its general effects on man are like those of sulphate of copper, but it is thought to be less disposed to occasion nausea and vomiting. An over-dose, however, readily acts as an emetic. Its action is probably somewhat more stimulating to the general system than the sulphate. It is employed in medicine as a tonic and antispasmodic.

Uses.—Internally it has been principally employed in chronic spasmodic affections; such as epilepsy, chorea, catalepsy, hysteria, spasmodic asthma, and eramp of the stomach. In epilepsy it has been much esteemed, and was found useful by Dr. Cullen (Treat. on Mat. Med.), and other accurate observers; but, like all other remedies for this curious disease, it frequently fails. It has also been used inague and dropsy. As a topical remedy, a solution of it has been employed as an injection in gonorrhœa and leucorrhœa; and as a collyrium to remove opacity of the cornea.

Administration.—It may be administered internally in doses of from half a grain gradually increased to five grains. It is usually exhibited in the form of pill; rarely in that of solution.

Pilule Ammoniaretii Cupri, Ph. Ed. (ammoniaret of copper, in fine powder, gr. xxj.; crumb of bread, 5iv.; water of carbonate of ammonia, q. s. Beat into a mass, and divide into thirty-two equal pills).—
Each pill contains half a grain of ammoniarect of copper. The dose is one to five or six pills.

**Liquor Cupri Ammonio-sulphatis**, Ph. Lond. *Cupri ammoniati aqua*, Ph. Dub. (Ammoniated copper, 5j.; distilled water, 3xx. dissolve and strain. In the Dublin Pharmacopoeia one part of the salt used to a hundred parts of distilled water).—It is applied to indolent ulcers as a stimulant and detergent; and, when diluted, to the eye, to move slight specks of the cornea.

*Cupre Subacetat.—Subacetate of Copper.*

**History.**—Hippocrates employed verdigris, which he terms *χαλκοῦ ὕδατα*, rust of copper, in diseases of the eyes, and as an astringent in haemorrhoids (Ed. Fæs. 635, 636 & 894). Theophrastus (*De Lapidibus*), Dioscorides (lib. v. cap. xci.), and Pliny (*Hist. Nat. xiiiiv.*) describe the method procuring it. The Romans called it *aerugo*. It is frequently termed acetate of copper; but this name is objectionable, since verdigris frequently occurs as a subacetate mixed with the trisacetate. I prefer the less precise, though more accurate term, *subacetate of copper*.

**Preparation.**—At Montpellier it is thus made:—The refuse of grapes allowed to ferment with sour wine, and is then laid in alternate strata with plates of copper: acetous fermentation takes place, and the metal becomes oxidized by the combined influence of the air and acid. In about fifteen days the plates are covered with the acetate of copper; they are then wetted, and exposed for a month to the air: the acetate absorbs water, and uniting with more oxide of copper, forms a subacetate, which is scraped off, and packed in leathern sacks for exportation. At Trenoble verdigris is obtained by sprinkling plates of copper with ready-made vinegar (Dumas, *Traité de Chim.* v. 169). In this country it is prepared by exposing thin plates of copper to the action of acetic acid, and its fumes: the method now practised consists in alternating plates of copper with pieces of woollen cloth steeped in acetic acid; they gradually become corroded, and superficially covered with verdigris, which is removed and replaced with fresh plates, until the last plate lasts (Brandle’s *Manual of Chemistry*). French verdigris is imported in sacks, weighing from 25 to 30 pounds.

**Properties.**—It occurs in masses or in powder. One variety is of a blue bluish green colour; another is blue. Its taste is astringent and metallic; its odour is somewhat similar to, though more disagreeable, acetic acid. It is insoluble in alcohol. Water resolves it into a soluble acetate and an insoluble trisacetate. Hence the *cupri subacetat separatum* of the Dublin Pharmacopoeia, and which is directed to be prepared by leivation and elutriation, is in fact the trisacetate, the verdigris having undergone a chemical change by the action of water.

**Characteristics.**—When digested with strong sulphuric acid, it dissolves acetic acid, which is readily distinguished by its odour. Heated in a glass tube it gives out acetic acid; the residue contains metallic copper. If verdigris be boiled in distilled water a solution is obtained, which is known to contain copper by its colour, and by the before-men- mened tests for the cupreous compounds (*vide* p. 493).

**Composition.**—The blue verdigris is a hydrated diacetate of copper.
Verdigris with a greenish tint consists of the subsesquiacetate and the trisacetate (Berzelius, Traité de Chimie, iv. 347 & 349). The composition of these salts is as follows:

<table>
<thead>
<tr>
<th>Oxide of copper</th>
<th>Acetic Acid</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>80</td>
<td>43.24</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>27.57</td>
</tr>
<tr>
<td>54</td>
<td>29.19</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>185</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Physiological Effects.—The action of verdigris on the system is very similar to that of the other preparations of copper: thus, taken in small and repeated doses, it acts on the nervous system, and is called tonic and antispasmodic; in larger doses it operates as an emetic; and, in excessive doses, is a powerful poison, producing both gastro-enteritis (indicated by vomiting, purging, and pain), and an attack of the nervous system (marked by insensibility, convulsions, and even tetanus).

Uses.—Verdigris, when taken into the stomach, being variable and dangerous in its operation, is never administered internally. It was formerly employed in obstinate syphilis, when mercurials failed.

The powder is sometimes employed as an escharotic. It is sprinkled over foul and indolent ulcers, or, when mixed with savin, is applied to destroy venereal warts. When used for the latter purpose it rarely fails.

Linimentum Äruginis, Ph. Lond. Oxymel cupri subacetatis, Ph. Dubl. (verdigris, powdered [prepared subacetate, Dubl.], 5j.; vinegar [distilled, Dubl.] f. 3vij.; clarified honey, 3xiv. Dissolve the verdigris in the vinegar, and strain the solution through linen; afterwards, the honey being added, boil down to a proper consistence).—This was formerly called Mel Ägyptiacum, Unguentum Ägyptiacum, or Oxymel Äruginis. It is stimulant, detergent, and slightly escharotic. It is applied by means of a camel's-hair pencil to venereal ulcers of the throat, as well as to other indolent ulcers. Diluted with water it is employed as a gargle.

Unguentum Cupri Subacetatis, Ph. Dubl.; unguentum cupri subacetatis, Ph. Ed. (Prepared subacetate of copper, 3ss.; olive oil, 5j.; ointment of white resin, ibj. M. Ph. Dubl.—Resinous ointment, 15 parts; subacetate of copper, in very fine powder, 1 part. M. Ph. Ed.)—This is a stimulant and mild escharotic. It is used as an application to foul ulcers, in ophthalmia tarsi, as a cure for the obstinate forms of ring-worm, and as an application to corns.

Andidotes.—Vide Cuprum.

Cu'pri Ac'etas.—Ac'etate of Copper.

This salt is commonly, though very, improperly, termed distilled or crystallized verdigris, and is met with in the shops crystallized on sticks. It is usually prepared by dissolving common verdigris in acetic acid, and crystallizing. The crystals are oblique rhombic prisms. They consist of one equivalent of oxide of copper, one equivalent of acetic acid, and one equivalent of water. This salt is completely soluble in water, by which it is distinguished from common verdigris. In most other properties it agrees with the latter. It is included in the list of materia
Order 22. — Bismuth and its Compounds.

Bismuthum.— Bismuth.

History.— This metal is first mentioned by Agricola, in 1529. It has been termed Marcasita, Tectum Argenti, or, by the Germans, Wismuth. The old miners called it Wismuth," says Matthesius, "because it blooms as a beautiful meadow (Wiesematte), on which variegated flowers of all kinds are glittering," (Schwartzc, Pharm. Tabellen).

Natural History.— Bismuth occurs only in the mineral kingdom. It was found in Cornwall, Saxony, Bohemia, &c. It is met with in the metallic state nearly pure (native bismuth), and in combination with sulphur and with oxygen.

Preparation.— It is chiefly obtained from native bismuth by melting the metal out of its gangue.

Properties.— It is a reddish white metal, without taste or smell, composed of brilliant broad plates, and readily crystallizable in cubes or angular octahedrons. Its specific gravity is 9.83 to 9.88. It is moderately hard, brittle, pulverizable, fusible at 476° F. When strongly heated in the air it takes fire, and burns with a faint blue flame, emitting a yellow smoke (bismuth oxide). In close vessels it may be volatilized. Its equivalent is 72.

Characteristics.— It is distinguished by its brittleness, its readiness of solubility, its solubility in nitric acid, and by the characters of the nitrate solution, which throws down a white precipitate on the addition of water, and a black one when hydrosulphuric acid or the hydrosulphates are added to it.

Purity.— Any arsenicum, which may be mixed with bismuth, is soluble in nitric acid: it is converted by the acid into an insoluble arseniate. Copper may be detected by precipitating the nitric solution with ammonia; the supernatant liquor is blue if copper be present.

Physiological Effects and Uses.— In the metallic state, bismuth is inert. Its only use is in the preparation of the trisnitrate.

Bismuthi Trisnitrat.— Trisnitrate of Bismuth.

History.— This compound was first prepared by Lemery. It has had various appellations, such as pearl or flake white, magistry of bismuth (so a name for submuriate of bismuth), Spanish white, subnitrate or Marto-nitrate of bismuth.

Preparation.— In the London Pharmacopoeia it is directed to be prepared by dissolving one ounce of bismuth in a fluid ounce and a half of nitric acid, to which six drachms of water have been added. After the solution has been filtered, about three pints of distilled water are to be added; the subnitrate precipitates, and is to be collected, washed, and dried.

In the Dublin Pharmacopoeia, seven parts of bismuth are dissolved in twenty parts of dilute nitric acid, and the solution added to a hundred parts of water.

In the first part of this process we obtain a nitrate of bismuth by the
re-action of three equivalents or 216 parts of bismuth, on four equivalents
or 216 parts of nitric acid. One equivalent or 30 parts of binoxide
of nitrogen are evolved, and three equivalents or 402 parts of nitrate of
bismuth formed.

**RESULTS.**

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Nitric Acid</td>
<td>1 eq. Binox.Nitrog. 30</td>
</tr>
<tr>
<td>2 eq. Bismuth</td>
<td>1 eq. Binox.Nitrog. 30</td>
</tr>
<tr>
<td>3 eq. Nitric Acid</td>
<td>3 eq. Binox.Nitrog. 30</td>
</tr>
</tbody>
</table>

When nitrate of bismuth is mixed with water, two bismuthic salts are
produced; a soluble supersalt (ternitrate), and an insoluble subsalt (tris-
nitrate).

**RESULTS.**

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Nitrate Bismuth</td>
<td>1 eq. Ternitrate Bismuth = 242</td>
</tr>
<tr>
<td>2 eq. Nitric Acid</td>
<td>54</td>
</tr>
<tr>
<td>3 eq. Nitrate Bismuth</td>
<td>1 eq. Trisnitrate Bismuth = 294</td>
</tr>
<tr>
<td>3 eq. Oxide Bismuth</td>
<td>240</td>
</tr>
</tbody>
</table>

**Properties.**—It is a dull white, inodorous, tasteless powder, which
consists of very fine silky needles. It is nearly insoluble in water, but is
readily dissolved by nitric acid. By exposure to light it becomes greyish.

**Characteristics.** — Hydrosulphuric acid, or the hydrosulphates,
blacken it, by forming the sulphuret of bismuth. It dissolves in nitric
acid without effervescence. Heated on charcoal by the blowpipe flame
it gives out nitrous acid, and yields the yellow oxide of bismuth; and, by
a continuance of the heat, the oxide is reduced, globules of metallic
bismuth being obtained, which may be readily distinguished from globules
of lead by their brittleness; for, when struck sharply by a hammer on an
anvil, they fly to pieces: from antimony they are distinguished by their
solubility in nitric acid.

**Composition.**—Its composition, according to Mr. Phillips (Phil. Mag.
Dec. 1830, p. 409) is as follows:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide of Bismuth</td>
<td>3</td>
<td>240</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>1</td>
<td>54</td>
</tr>
<tr>
<td>Trisnitrate of Bismuth</td>
<td>1</td>
<td>294</td>
</tr>
</tbody>
</table>

**Purity.**—Its freedom from any carbonate (as of lead) is distinguished
by its solution in nitric acid without effervescence. Sulphuric acid
added to the solution throws down a white precipitate, if lead be present.

**Physiological Effects.** (a.) On animals.—It acts as a local irritant
and caustic poison. Moreover it appears to exercise a specific influence
over the lungs and nervous system (Orfila, Toxicol. Gén.)

(b.) On man.—In small doses it acts locally as an astringent, diminish-
ing secretion. On account of the frequent relief given by it in painful
affections of the stomach, it is supposed to act on the nerves of this
viscous as a sedative. It has also been denominated tonic and antispas-
motic. Vogt (Pharmakodynamik, i. 288, 2ne Aufl.) says, that when used
as a cosmetic, it has produced a spasmodic trembling of the muscles of
the face, ending in paralysis.

**Large medicinal doses** disorder the digestive organs, occasioning pain,
vomiting, purging, &c.; and sometimes affecting the nervous system, and
producing giddiness, insensibility, cramps of the extremities, &c.

The following is the only reported case of poisoning with it. A man
took two drachms by mistake, and died therefrom on the ninth day. In
Addition to the usual symptoms of gastro-enteritis, there was a disordered condition of the nervous system, indicated by cramps of the hands and feet, disordered vision, and delirium. It is deserving also of mark, that there were difficulty of breathing, and salivation. Post-mortem examination showed inflammation throughout the alimentary canal; the spinal vessels were gorged with blood, particularly towards the cauda equina; there was fluid in the cerebral ventricles; and the inner surface of both ventricles of the heart was very red (Christison’s treatise on Poisons).

We have not at present sufficient evidence before us to determine whether this medicine affects the general system by absorption or through the intervention of the nervous system; its insolubility has led to the conclusion that it does not become absorbed.

Use.—It has been principally employed in those chronic affections of the stomach which are unaccompanied with any organic disease, but which apparently depend on some disordered condition of the nerves of this viscus; and hence the efficacy of the remedy is referred to its supposed action on these parts. It has been particularly used and recommended to relieve gastrodynia and cramp of the stomach, to allay sickness and vomiting, and as a remedy for the waterbrash. It has also been administered in intermittent fever, in spasmodic asthma, &c. Hahnemann has recommended a portion to be introduced into a hollow tooth, to allay tooth-ache. I have used it, with advantage, in the form of ointment, applied to the septum nasi, in ulceration of this part, and as a local remedy in chronic skin diseases.

Administration.—The usual dose of this remedy is from five grains to a scruple, exhibited in the form of a pill. The ointment which I have just referred to was composed of one drachm of the subnitrated, and half an ounce of spermaceti ointment.

Antidotes.—No chemical antidote is known. Emollient drinks should be administered, and the poison evacuated from the stomach as speedily as possible. The antiphlogistic plan is to be adopted, to obviate inflammation.

Order 23.—Tin.

Stannum—Tin.

History.—Tin has been known from the most remote periods of antiquity. It is mentioned by Moses (Numbers, xxxi. 22) and by Homer (Iliad, xi. 25). The alchemists called it Jove, or Jupiter.

Natural History.—It is peculiar to the mineral kingdom. It occurs in two states; as an oxide (the tin stone and wood tin of mineralogists), and as a sulphuret (tin pyrites). It is found in both states in Cornwall, which has long been celebrated for its tin works. The Phoenicians, who were perhaps the first people who carried on commerce by sea, traded with England and Spain for tin at least 1000 years before Christ.

Preparation.—In Cornwall, stream tin (a variety of tin stone) is melted with charcoal. The metal thus procured is subsequently made hot, and then let fall from a height, by which it splits into a number of irregular prisms, somewhat like a basalt pillar. This is called grain tin. Mine tin (another variety of tin stone) is ground, washed, roasted, and
afterwards smelted with Welsh culm and limestone, by which block tin is procured; the finest kind of which is called refined tin (Mr. John Taylor, Ann. Phil. iii. 449).

Besides the two varieties of tin just described, other kinds are met with in commerce. Malacca tin occurs in quadrangular pyramids, with flattened bases. Banca tin is met with in wedge-shaped pieces.

Properties.—In its massive form it is a yellowish-white metal, having a peculiar odour when rubbed or handled. Its sp. gr. is 7·29. It melts at 442° F. and at a white heat is volatilized. It is malleable, and forms sheet tin and tin foil (stannum foliatum), but is sparingly ductile. Its equivalent is 58.

Tin may be reduced to powder, by pouring melted tin into an iron mortar, and rubbing until it is cold; or by shaking melted tin in a wooden box, the inside of which has been rubbed with chalk. In this state it constitutes powdered or granulated tin (pulvis stannii, Ph. Dub., Ed. and U. S.) This as well as tin filings (stanni limatura, Ph. Ed. seu rasura stanni) have been used in medicine.

Characteristics.—Boiled in strong hydrochloric acid, we obtain a solution of protochloride of tin, which possesses the following characters:—Potash causes a white precipitate, soluble in excess of the precipitant; hydrosulphuric acid, a brown; and chloride of gold, a purple precipitate (the purple powder of Cassius). If protochloride of tin be heated with nitric acid, we obtain a perchloride which causes a yellowish precipitate with hydrosulphuric acid.

Physiological Effects.—In the mass, tin has no operation on the body, except that arising from its form and weight. Powdered tin is not known to produce any disorder in the functions of the body. It appears, however, that acid, fatty, saline, and even albuminous substances, may occasion colic and vomiting by having remained for some time in tin vessels. Oxide of tin is poisonous, according to Orfila (Toxicol. Gén.); but Schubarth (quoted by Dr. Christison, Treat. on Poisons) found it inactive.

Uses.—Powdered tin has been employed with great success by various eminent practitioners, as a vermifuge, particularly in tape-worm. Dr. Alston (Med. Essays, v. 89, 92; also Lect. on Mat. Med. i. 150) explains its operation on mechanical principles: he supposes that the powder of tin gets betwixt the worms and the inner coat of the alimentary canal, and causes them to quit their hold, so that purgatives easily carry them away with the feces. It has, however, been asserted that water in which tin has been boiled is anthelmintic, at least so says Pitcairn and Pietsch (quoted by Richter, Ausf. Arzneim. iv. 553); wine which has been digested in a tin vessel is also said to be noxious to worms. If these statements be true, the before-mentioned mechanical explanation is inadmissible. Some have, therefore, supposed that the efficacy must depend on the tin becoming oxidized in the alimentary canal; others have fancied that arsenic, which is frequently found in tin, is the active agent; while, lastly, some have imagined that the metal, by its action on the fluids of the canal, generated hydrogen, or hydrosulphuric acid, which destroyed these parasites.

Dr. D. Monro (Treat. on Med. and Pharm. Chem. i. 289), Fothergill, and Richter, have used powdered tin in epilepsy produced by worms, and, as it is stated, with advantage.
LEAD.

Administration.—The usual mode of exhibiting it is mixed with treacle: the dose usually stated in pharmaceautical works is one or two emulsions, but Alston gave much larger quantities; his mode of employing it as a vermicifuge was the following:—The patient was well purged with emna, and on the following morning one ounce of tin powder was given; four ounces of treacle; on each of the two following days half this quantity was taken, and then the patient again purged. However, tin powder is certainly much inferior to oil of turpentine as a remedy for pe-worm.

Order 24.—Lead and its Compounds.

Plumbum.—Lead.

History.—This metal was known in the most remote ages of antiquity. It is mentioned by Moses (Job, xix. 23, 24.) The Greeks called it αδεσχος; the alchemists, Saturn.

Natural History.—It is found in the metallic state (native lead), combined with sulphur (galena), with selenium, with chlorine (horn). It is also found in the form of compound, with oxygen (native minium), and with oxygen and an acid, forming oxo-salt (carbonate, phosphate, sulphate, tungstate, molybdate, chromate, selenate, and aluminate.)

Preparation.—It is usually extracted from galena, which is roasted reverberatory furnaces, by which it is converted into a mixture of sulphate and oxide of lead, and afterwards smelted with coal and lime, the first to abstract oxygen, the second to remove the sulphur.

Properties.—It has a bluish-gray colour and considerable brilliancy. It may be crystallized by cooling in four-sided pyramids. It is malleable, but not ductile. Its sp. gr. 11.35. It has a peculiar odour when boiled. It fuses at 613° F. and at a red heat boils and evaporates. An equivalent is 104. By exposure to the air it attracts, first oxygen, and then carbonic acid, so as to form carbonate of lead.

Pure distilled water has no action on lead, if the gases (as air and carbonic acid) be excluded; but if these be admitted, a thin crust of carbonate is soon formed. It is remarkable that the presence of most neutral salts—sulphate of soda and chloride of sodium, for example—pairs the corrosive action of air and water. Hence, therefore, we can easily comprehend the reason why leaden cisterns and pipes do not more frequently give a metallic impregnation to water; and why rain-water is ore apt than spring-water to become impregnated with lead. The latter, however, by long keeping in leaden vessels, may also become contaminated with lead.

Characteristics.—If lead be dissolved in nitric acid, we may easily recognise its presence in the solution by the following tests:—Alkalis, their carbonates, sulphuric acid and the sulphates, and ferrocyanide of stassium, produce white precipitates; chromate of potash and iodide of stassium, occasion yellow precipitates; hydrosulphuric acid and the hydrosulphates form black precipitates of the sulphuret of lead; lastly, a piece of zinc throws down metallic lead in an arborescent form.

The delicacy of these tests is, according to Devergie (Méd. Lég. ii. 779), as follows:—
PHYSIOLOGICAL EFFECTS.—1. Metallic lead.—I believe that so long as lead retains its metallic form it is inert. In a French journal (Journ. de Méd. de Leroux, xxiii. 318) we are told that three ounces and six drachms of this metal have been given to a dog without any obvious effects. As, however, it is a metal which is readily oxidized, it occasionally proves active when swallowed, in consequence of its being acted on and oxidized by the contents of the alimentary canal. An instance of this kind is mentioned by Paulini (Miscell. Nat. Cur. Dec. ii. Ann. vi. App. p. 7. quoted by Voigtel, Arzneimittelehre), in which colic was produced by swallowing a leaden bullet. Proust (Ann. de Chim. lvii. 84) says, that the alloy of lead and tin may be swallowed with impunity, in consequence of its being much less easily oxidized than the pure metal.

2. Of the preparations of lead. (a.) On vegetables.—Marcet found the solution of acetate of lead injurious to plants; but Wiegmann declares it to be inert, and ascribes its inertness to the formation of an insoluble salt (carbonate) of lead by the carbonic acid of the roots of plants.

(b.) On animals.—The preparations of lead are, for the most part, energetic poisons. The sulphuret, however, appears to be inactive, or nearly so; for Orfila (Toxicol. Gén.) gave an ounce of it to dogs without observing any ill effects; four ounces have even been given to horses without any unpleasant results. The sulphate, also, according to Orfila, is inactive. Our knowledge of the effects of the salts of lead on animals is derived from experiments made with the acetates, nitrate, and carbonate. The first two act as corrosives: all affect the nervous system, manifested by convulsions, palsy, and colica pictorum. (Christison, Treat. on Poisons, 506 et seq. 3d ed.)

(c.) On man.—Mr. Braid (Christison, op. cit. 518) states that workmen who dig and pulverize the ore (sulphuret of lead), at the lead-mills in Lancashire, never have the lead colic until they work at the smelting furnaces.

Most, if not all, the other preparations are more or less active; the effects and symptoms, however, vary with the dose.

In small doses these preparations act on the alimentary canal as astringents; checking secretion and causing constipation. These may be regarded as the local effects. When absorbed, the constitutional effects of lead are observed: the arteries become reduced in size and activity, for the pulse becomes slower and smaller; the temperature of the body is diminished; and sanguineous discharges, whether natural or artificial, are frequently checked, or even completely stopped. This constraining and sedative effect seems extended to the secreting and exhaling vessels; the discharges from the mucous membranes, the exhalation from the skin, and the urine, being diminished in quantity. Thus we observe dryness of the mouth and throat, thirst, greater solidity of the alvine evacuations, diminution of the bronchial secretion, and of
utaneous exhalation. From all these circumstances it would appear that these preparations give rise to a contracted state of the coats of the blood-vessels (at least of the arteries.) It is not at all improbable that the coats of the absorbents are similarly affected, as has been asserted. If this be the case, some obstruction would probably be offered to the passage of lymph; the functions of absorption would be carried on with less energy, and the lymphatic glands would perhaps become in consequence affected; the wasting of the body produced by lead in these small doses has been denominated *tabes saturnina*, or *tabes sicca*.

The long-continued use of the preparations of lead rarely fails to give evidence of its effect on the muscular and nervous systems, and which is manifested by a curious train of symptoms, commencing with colic, and terminating in palsy or apoplexy. *Lead or painter's colic (colica pictorum)* is variable in its mode of attack; at one time commencing suddenly, and without any very marked premonitory symptoms, at another being preceded by dyspeptic symptoms—such as diminished appetite, with a painful and constipated state of the bowels, the faeces being very hard. During an attack, there is usually obstinate constipation, with acute pain, much increased at intervals; but sometimes a relaxed condition of the bowels has been met with. *Merat (Traité de la Colique Métallique)* refers the continued pain to the small intestines, while the more violent and intermitting kind resides principally in the transverse portion of the colon. Pressure rarely increases, and very commonly relieves, the pain. Cases, however, do occur (and I have seen several) in which there is great tenderness of the bowels. The abdomen is strongly retracted, sinks in about the navel, and feels very hard. To these symptoms may be added vomiting, cramps of the lower extremities, hard and generally slow pulse, though sometimes it has been found frequent.

De Haen and Merat, on examining the bodies of patients who have died affected with lead colic, found a contracted condition of the colon, and this was considered by the last-mentioned writer to indicate the seat of the disease. But Sir G. Baker, Andral (*Path. Anat.* by Townsend and West, ii. 140), Louis, and Copland (*Dict. Pract. Med.* i. 366), have not, in some cases, found any alteration. Moreover, it would appear probable from Dr. Abercrombie's observations on ileus, *On Diseases of the Abdom. Viscera* that the empty and collapsed portion of the intestine was not the seat of the colic, but another part found in a state of distension,—for the collapsed or contracted state is the natural condition of healthy intestine when empty; while the distended portion is, in ordinary cases of ileus, the primary seat of the disease, the distension arising from a paralytic condition of the muscular fibres, whereby it is unable to contract and propel its contents onward. Now this view of the case is the more probable, since the action of lead on the muscular fibres of the intestine is regarded as of the same kind as that on the fibres of the voluntary muscles. Some have found intus-susception, others have noticed marks of inflammation.

Another effect of poisoning by lead is an affection of the cerebro-spinal system, generally manifested by *paralysis*, but occasionally by giddiness, convulsions, and coma, and now and then by apoplexy. The palsy may occur without colic, or it may come on while the patient is suffering with it, but in general it succeeds colic. It may happen in both upper and lower extremities, though more frequently in the former; and it affects
the extensor more than the flexor muscles, so that the hands are generally bent on the arms, which hang dangling by the side. Frequently pain is experienced in the paralyzed part, and sometimes in the region of the spine also. On examining the bodies of persons who have died with this disease, no lesion has hitherto been discovered in the spinal marrow. The muscles of the affected limb are observed to be wasted and very pale, and have sometimes the appearance of a white fibrous tissue.

In very large doses, some of the plumbeous preparations (the acetate, for example) act as irritant and caustic poisons; giving rise to the usual symptoms indicative of gastro-enteritis. However, none of them equal, in the intensity of their local action, the mercurial or even the cupreous compounds.

Modus Operandi.—Tiedemann and Gmelin (Vers. über d. Wege, wie Subst. aus d. Mag. ins Blut, gelang.) found lead in the blood of the splenic, mesenteric, and hepatic veins of dogs killed by the acetate; they also found it in the contents of the stomach and intestines, but neither in the chyle nor the urine. Wibmer (Christison’s Treatise on Poisons, 3d edit. p. 509) detected it in the liver, muscles, and spinal cord.

The local or corrosive action of the soluble salts of lead depends on the affinity of these bodies for the organic constituents of the tissues (vide Plumbi Acetas).

The nervous system is specifically affected by lead. The paralysis of the voluntary muscles, the pain in the course of the spine, the occasional giddiness, coma, or apoplexy, seem to establish this. The colic as well as the astringent influence of lead over the coats of vessels are probably secondary effects of the action of lead over the nervous system.

The constitutional effects of lead may be produced in various ways: as, when taken with articles of food and drink into the stomach; when inhaled in the form of dust or vapour with the air; when applied to mucous membranes, ulcers, &c. Hence the persons most liable to these effects are those whose occupations bring them in contact with this metal; for example, painters, plumbers, roasters and smelters of lead, the manufacturers of the plumbeous preparations, glass-blowers, potters, lapidaries, &c.

Dr. Anthony Todd Thomson (Lond. Med. Gaz. v. 538, and x. 689) is of opinion, that carbonate of lead is the only preparation of this metal that can produce colic: and though he has, I think clearly, shewn that lead colic more frequently arises from the carbonate than from any other salt of lead, he has, in my opinion, failed in proving that no other preparation of lead can produce it. Indeed, if his opinion were true, it would constitute an exception to the general effects of the metallic preparations; for we do not find that the specific effects of arsenic, or of mercury, or of copper, or of antimony, are produced by one preparation only; so that, à priori, analogy is against the opinion. Furthermore, it is well known that the vapour of the oxide of lead taken into the lungs may produce colic, and that the ingestion of the acetate, citrate, or tartrate of lead, is capable of exciting the same effect. Now Dr. Thomson explains these facts by assuming that the oxide of lead unites with carbonic acid in the lungs, and is thus converted into carbonate: and that the acetate, citrate, and tartrate, are decomposed in the alimentary canal, and converted into carbonates. But it appears to me to be much more
ample and consistent with analogy, to admit that these preparations are of themselves capable of producing colic, than to assume that they undergo the changes here supposed. Moreover, in some instances in which colic was produced, it is unlikely that these changes could have occurred, owing to the excess of acid taken with the salt of lead.

Uses.—The uses of the preparations of lead may be in part inferred from the foregoing account of their effects. These agents are employed when we wish to constringe the capillary vessels and to diminish their vital activity. Thus we administer them internally to check excessive secretion and exhalation, as in catarrhal affections of the mucous membranes of a chronic nature; in profuse secretion of pus; in sanguineous exhalations from the mucous membranes; and in colliquative sweating. They have also been applied, in some instances with success, in certain chronic affections of the nervous system, as epilepsy; but the practice is altogether empirical, as we have no rational principles to guide us in using them. As topical remedies, we employ the preparations of lead to diminish vascular excitement, to allay preternatural heat, and to check excessive secretion. Thus we apply them to inflamed parts to promote resolution, and to ulcers and other secreting surfaces as astringents or desiccants. During the internal employment of lead, attention must be paid to the condition of the stomach and bowels, as we find the traces of their injurious effects in these organs. Constipation is a very frequent result of their medicinal employment. Loss of appetite, indigestion, and griping pains, are also often noticed. The tendency to colic is diminished, according to Dr. A. T. Thomson, by conjoining acetic acid.

Antidotes.—Poisoning by lead usually puts on one of three forms—irritant poisoning, lead colic, and paralysis.

1. Irritant poisoning.—Administer diluents holding in solution some sulphate (as sulphate of soda, of magnesia, or of potash or alum), so that a sulphate of lead may be formed. If vomiting have not already come on, tickle the throat, and administer emetics of the sulphate of zinc or of copper, or the stomach-pump may be employed.

2. Lead colic.—Here the best remedy is alum (vide pp. 372, 373). But in this country lead colic is frequently treated by the combined use of purgatives and anodynes, the purgatives being either castor oil or salts and senna, the anodyne being opium. When the vomiting is very troublesome, and liquid medicines do not remain on the stomach, we may give the compound extract of colocynth, with opium, in the form of pill. In several cases in which the pulse was full and strong, the face flushed, and the tongue furred and dry, I have used blood-letting with evident advantage. The sulphates have been recommended, as also mercury.

3. Lead paralysis.—Nux vomica, and its active principles—strychnia and brucia, are perhaps of all internal remedies most deserving of trial, because of their specific effect on the spinal marrow; and the chance of their success is, of course, much increased by the circumstance of there being no discoverable lesion of this portion of the nervous system. Mercury has been recommended by Dr. Clutterbuck. Various local measures have been tried, but without much benefit; for example, electricity and irritants (such as ammonia and cantharides).
**Plumbi Ox'y'dum.—Ox'ide of Lead.**

**History.**—The ancients were acquainted with oxide (or protoxide) of lead. Hippocrates (De Morb. Mul. ii.) employed the semi-vitrified oxide (litharge, λιθάργυρος). Dioscorides (lib. v. cap. cii.) and Pliny (Hist. Nat. xxxiv. 53) both mention litharge: the latter calls it molybdæna.

**Preparation.**—Litharge is usually obtained as a secondary product in the cupellation of argentiferous lead. The alloy is melted on a porous vessel, called a test or cupel, and exposed to the blast of a bellows, by which the lead is oxidized, half vitrified, and driven off into hard masses of a scaly texture, and is called, in that state, litharge or silver stone (Watson's Chem. Essays, iii. 325, 6th ed.)

The compound called in the London Pharmacopœia hydrated oxide of lead (plumbi oxydum hydratum) is prepared by mixing six pints (or as much as may be sufficient) of solution of potash with six pints of solution of diacetate of lead and three gallons of distilled water. The precipitate is to be washed until nothing alkaline remains. In this process the potash combines with acetic acid, and forms acetate of potash, which remains in solution; while a white compound, called by Mr. Phillips hydrated oxide of lead, is precipitated. But it is stated, that “oxide of lead does not form a hydrate with water, the white powder which caustic alkalies throw down in solution of lead being a basic (sub) salt” (Geiger's Handb. d. Pharm. von J. Liebig).

**Properties.**—Oxide of lead presents itself in several forms. One of these is yellow, and is termed Massicot (cerussa citrina). When semivitrified (plumbi oxydum semivitreum), it is called litharge (lithargyrum), which occurs in the form of small yellow or reddish scales or flakes, and, according to its colour, is called gold or silver litharge (lithargyrum aureum [chrysitis] seu argenteum [argyritis]). The plumbi oxydum hydratum, Ph. Lond., is a perfectly white powder.

Oxide of lead is fusible, and at a very high temperature volatile. When heated in contact with charcoal or carbonaceous bodies, it is readily reduced to the metallic state. It is insoluble in water.

**Characteristics.**—Heated on charcoal by the blowpipe, it is readily reduced to the metallic state. It is blackened by hydrosulphuric acid, and completely dissolves in nitric acid. The characteristics of this solution have been already described (vide p. 505). The varieties of the oxide are distinguished by their physical peculiarities.

**Composition.**—Oxide of lead is thus composed:

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<tbody>
<tr>
<td>Lead</td>
<td>1</td>
<td>104</td>
<td>92:85</td>
<td>92:85</td>
<td>93:3</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>7:14</td>
<td>7:15</td>
<td>6:7</td>
</tr>
<tr>
<td><strong>Oxide of Lead</strong></td>
<td><strong>1</strong></td>
<td><strong>112</strong></td>
<td><strong>99:99</strong></td>
<td><strong>100:00</strong></td>
<td><strong>100:0</strong></td>
</tr>
</tbody>
</table>

**Physiological Effects.**—Inhaled in the form of vapour, or fine dust, it produces the before-mentioned constitutional effects of lead (vide p. 506).

The effects of this substance, when swallowed, are but little known. It possesses very slightly irritant properties. “The experimentalists of
ions found litharge to be irritant in large doses of half an ounce,”
christison, op. cit. p. 509).
From its external use ill consequences have sometimes resulted.
USES.—The oxides of lead are never employed internally. Litharge
sometimes sprinkled over ulcers, as an astringent and desiccating
substance.
In pharmacy, litharge is used in the preparation of emplastrum
umbi, ceratum saponis, acetas plumbi, and liquor plumbi
acetatis.
The plumbi oxydum hydratum, Ph. Lond., is directed to be used in
preparing quinine sulphas. But the Pharmacopoeial process for making
the latter substance has not been found by manufacturers to answer,
and, therefore, the hydrated oxide of lead is, in fact, not employed in
pharmacy.
HAIR DYE.—Various powders, pastes, and liquids, have been pre-
pared for dyeing the hair brown or black (Journ. de Chim. Méd. ii. 250,
Ser.) In general a mixture, or rather compound, of litharge and
lime is employed. The preparation sold as Olfila’s hair dye is of this
kind. The proportions are one part of each, or three parts of litharge
and two of lime. Sometimes carbonate of lead is partially or wholly
substituted for litharge. The mixture is made into a paste with hot
water or milk, and applied to the hair for four or five hours, the
paste being enveloped in oil-skin or a cabbage leaf. The water causes
the oxide of lead to combine with the lime, and thereby form a saline
compound, called plumbite of lime. The lime is useful by removing the
slippery matter of the hair, while the oxide of lead forms, with the sulphur
contained in the oil of the hair, a black sulphuret of lead. Dyed hair is
coarse and crisp. The mode of detecting stained hair has been described
by the late Dr. Cummin (Lond. Med. Gaz. xix. 215), and by Devergie
(Pharmac. Méd. Lég. ii. 931).

Plumbi Chloridum.—Chloride of Lead.

NATURAL HISTORY.—Chloride of lead occurs in the mineral
kingdom.

PREPARATION.—In the London Pharmacopoeia this compound is
directed to be prepared as follows:—Dissolve 19 ounces of acetate of lead
three pints of boiling distilled water, and 6 ounces of chloride of
sodium in one pint of boiling distilled water: mix. Wash the precipi-
tate when cold with distilled water, and dry it.
In this process one equivalent or 163 parts of dry acetate of lead are
composed by one equivalent or 60 parts of chloride of sodium; by
such one equivalent or 140 parts of chloride of lead are precipitated,
done equivalent or 83 parts of acetate of soda remain in solution.

RESULTS.

<table>
<thead>
<tr>
<th>1 eq. Chloride of Sodium</th>
<th>1 eq. Chloride of Lead</th>
<th>1 eq. Acetate of Acid</th>
<th>1 eq. Acetate of Lead</th>
<th>1 eq. Acetate of Oxide</th>
<th>1 eq. Oxide of Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>140</td>
<td>51</td>
<td>163</td>
<td>112</td>
<td>12</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>40</td>
<td>240</td>
<td>177</td>
<td>19</td>
</tr>
<tr>
<td>1 eq. Chloride of Lead</td>
<td>1 eq. Acetate Soda</td>
<td></td>
<td>1 eq. Acetate Soda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>163</td>
<td></td>
<td>163</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>163</td>
<td></td>
<td>163</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

hydrochloric acid occasions the precipitation of more chloride of lead
over the action of the chloride of sodium is over; so that there must be
one compound of lead in solution (Phillips, Transl. of Pharm. 3rd ed.)
PROPERTIES.—It is a white crystalline powder \((\textit{magisterium satura}}l \textit{Crollii})\), soluble in thirty parts of cold or twenty-two parts of boiling water. When heated it fuses; and by cooling forms a semitransparent horny-like mass, called \textit{horn lead} \((\textit{plumbum corneum})\).

CHARACTERISTICS.—Its aqueous solution causes a white precipitate with nitrate of silver, soluble in ammonia but insoluble in nitric acid; hence it is shown to be a chloride. The solution is known to contain lead by the before-mentioned tests for this metal \((\textit{vide} \ p. \ 505)\).

COMPOSITION.—The following is its composition:

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>1</td>
<td>104</td>
<td>74%</td>
<td>74%</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1</td>
<td>36</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Chloride of Lead</td>
<td>1</td>
<td>140</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

USE.—It is employed in the preparation of hydrochlorate of morphia.

\textit{Plum’bi Io’didum.}—\textit{Iodide of Lead}.

HISTORY.—This compound was introduced into medicine by Cottereau and Verdé-Delisle.

PREPARATION.—It is prepared by adding a solution of iodide of potassium to a solution of acetate of lead. The reacting proportions are 166 parts of iodide and 190 of crystallized acetate. In the London Pharmacopœia, the proportions directed to be employed are seven ounces of iodide of potassium and nine ounces of acetate of lead: the quantity of iodide of potassium is, therefore, larger than theory would dictate, supposing the acetate to be neutral. This excess is disadvantageous, since it retains a portion of the iodide of lead in solution. To prevent the formation of an oxyiodide of lead, a little acetic acid should be added to the acetate of lead, before adding the iodide of potassium. The precipitate should be washed and dried.

By the mutual reaction of one equivalent or 163 parts of dry acetate of lead, and one equivalent or 166 parts of iodide of potassium, we obtain one equivalent or 230 parts of iodide of lead, and one equivalent or 99 parts of dry acetate of potash.

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Acet.</td>
<td>1 eq. Acetic Acid</td>
</tr>
<tr>
<td>Lead, 163</td>
<td>1 eq. O. Lead</td>
</tr>
<tr>
<td>1 eq. Iodide</td>
<td>1 eq. Potassium</td>
</tr>
<tr>
<td>Potassium, 166</td>
<td>1 eq. Iodine</td>
</tr>
</tbody>
</table>

PROPERTIES.—It is a fine yellow powder, very sparingly soluble in cold water, but readily soluble in boiling water; from which it for the most part separates, as the solution cools, in the form of golden yellow, brilliant, small scales. It is fusible. It combines with the alkaline iodides, forming a class of double salts, called the \textit{plumbo-iodides} \((\textit{iodo-plumbates}, \textit{Thomson})\). Caustic potash dissolves it, and forms a plumbiodide of potassium and plumbate of potash \((\text{Dumas, Traité de Chim. iii. 379})\). It is soluble in acetic acid and in alcohol.

CHARACTERISTICS.—When heated, it first forms a yellow vapour (iodide of lead), and afterwards a violet vapour (iodine), leaving a residue (lead), which, when dissolved in nitric acid, gives all the characters of a
TION OF LEAD (vide p. 505). Boiled with carbonate of potash, it forms carbonate of lead and iodide of potassium.

COMPOSITION.—Its composition is as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>1</td>
<td>104</td>
<td>45.21</td>
<td>45.1</td>
</tr>
<tr>
<td>Iodine</td>
<td>1</td>
<td>126</td>
<td>54.78</td>
<td>54.9</td>
</tr>
<tr>
<td><strong>Iodide of Lead</strong></td>
<td>1</td>
<td>230</td>
<td>99.99</td>
<td>100.0</td>
</tr>
</tbody>
</table>

PURITY.—It should be completely soluble in boiling water.

PHYSIOLOGICAL EFFECTS. (a.) On animals.—Twenty-four grains of iodide of lead were given to a cat at two doses, with an interval of four hours: the animal suffered violent colic, and died in three days; but no signs of irritation were observed after death (Paton, Journ. de Chim. iii. 2nd Ser.) Iodide of lead was given in doses of from gr. v. to 5 ss. to a bull-dog: no effect was observed until the fifteenth day, when the animal refused food, and kept in the recumbent posture. He died on the eighteenth day, having swallowed altogether ten drachms and fifty grains iodide. During the whole period, he had only three or four intestinal evacuations (Cogswell, Essay on Iodine, 143).

(b.) On man.—Its effects on man have been imperfectly determined. It does not appear to act as an irritant when applied to the skin or operated surfaces. Under the continued external and internal use of it, enlargements of the lymphatic glands have disappeared, from which we infer a specific influence over the glandular and lymphatic system. In one case it appeared to occasion irritation of the stomach. I have seen constipation induced by it.

USES.—It has been principally employed to reduce the volume of violent tumors, especially enlargements of the cervical, axillary, and mesenteric glands. In these cases it should be simultaneously administered internally and externally. I have used it in two cases of enlarged cervical glands, but without benefit. Velpeau (Lugol’s Essays, by Dr. Shaughnessy, p. 206) and others, however, have been more successful.

ADMINISTRATION.—The dose is half a grain gradually increased. Dr. Shaughnessy (Lugol’s Essays, p. 207) says, ten-grain doses are easily borne, without the slightest annoyance.

UNGUENTUM PLUMBI IODIDI, Ph. Lond. (iodide of lead, ½ j. ; lard, ½ j. M.)—This is applied, by way of friction, to scrofulous and other violent swellings.

Plum’bi Car’bonas.—Car’bonate of Lead.

HISTORY.—This substance was employed by Hippocrates (De Morbis, ii.), under the name of ψυμμιευςον. Theophrastus (De Lapidibus) described the method of making it. Dioscorides (lib. v. cap. ciii.) and Pliny (Hist. Nat. lib. xxxiv.) also mention it.

It has been known by several names, as psimmythium, ceruse (cerussa), mystery of lead (magisterium plumbei), white lead, and subcarbonate of lead.

NATURAL HISTORY.—This salt is found native, crystallized, or massy, in Scotland, England, &c. It is called white-lead ore.

PREPARATION.—The old method of obtaining it is by exposing coils of tin-plate, placed perpendicularly in earthen pots, to the vapour of lead.
acetic acid. The pots, in the bottom of which is contained the acid, are buried in stable litter or tanners' bark. The plates become corroded and covered with carbonate of lead. In this process, the lead, when in contact with acetic vapour, rapidly abstracts oxygen from the air, and the oxide which is formed, combining with some acetic acid, forms a sub-acetate, which is decomposed by the carbonic acid of the air, forming carbonate and the neutral acetate of lead. The latter is reconverted into a subsalt, and is then decomposed by carbonic acid. At the end of the process, a small quantity of acetate of lead remains mixed with the carbonate, and is removed by washing.

Pure carbonate of lead may be procured by adding a solution of an alkaline carbonate to a solution of acetate of lead.

Carbonate of lead may be also procured by passing carbonic acid (obtained by the combustion of charcoal or coal) through a solution of subacetate or subnitrate of lead.

Properties.—The primary form of the crystals of the native carbonate of lead is a right rhombic prism. Artificial carbonate is a heavy, snow-white, tasteless powder, or in white chalk-like masses. It is insoluble in water, but dissolves in caustic potash. When heated it gives out carbonic acid, and forms the yellow oxide.

Characteristics.—Heated before the blow-pipe, on charcoal, it yields metallic lead. It is blackened by hydrosulphuric acid. It dissolves in nitric acid with effervescence. The solution possesses the general characters of the plumbeous solutions already described (vide p. 505).

Composition.—Its composition is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>Berzelius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide of Lead</td>
<td>1</td>
<td>112</td>
<td>83.58</td>
<td>83.5</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>1</td>
<td>22</td>
<td>16.42</td>
<td>16.5</td>
</tr>
<tr>
<td>Carbonate of Lead</td>
<td>1</td>
<td>134</td>
<td>100.00</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Purity.—Carbonate of lead of commerce is rarely pure. It is usually adulterated with earthy or metallic sulphates (as of lime, baryta, or lead.) These are detected by their insolubility in diluted nitric acid. Chalk (which is by some used to adulterate it) may be detected as follows:—Dissolve the suspected substance in nitric acid, and precipitate the lead by hydrosulphuric acid. Boil and filter the solution, in which will be contained nitrate of lime (if chalk had been present), recognizable by oxalic acid or oxalate of ammonia (vide p. 343.)

Physiological Effects.—Its local effects are not very powerful: applied to ulcerated surfaces, it acts as a desiccative and astringent substance: swallowed in large quantities, it does not act as a local irritant, like the acetate. Its constitutional effects are similar to those of the other preparations of lead, already described. It appears probable (vide p. 508) that carbonate of lead more frequently produces colic than the acetate of lead—a circumstance which Dr. Christison thinks may be owing to the great obstinacy with which its impalpable powder adheres to moist membranous surfaces, and the consequent greater certainty of its ultimate absorption.

Uses.—It is never administered internally.

Externally it is employed as a dusting powder in excoriations of children and lusty persons; but the practice is objectionable, on account of the
ACETATE OF LEAD.

In one case, related by Kopp (Richter, Ausführ. zeim, iv. 613) a child was destroyed by it. Unguentum Plumbi Carbonatis, Ph. Dubl. and Ed. (Carbonate lead, reduced to very fine powder, \(\frac{3}{ij}.\) ointment of white wax, 1 bj. M. (The Edinburgh formula is one part of carbonate of lead, and five parts simple ointment).—This ointment is valuable as a cooling and desiccative application to excoriated surfaces or burns.

An ointment or plaster of carbonate of lead has been known to give relief in some cases of neuralgia (Journ. de Pharm. xx. 603).

Plumbi Acetas.—Acetate of Lead.

History.—Raymond Lully and Isaac Hollandus were acquainted with this salt in the 13th century. It has been known by several appellations, sugar of lead (saccharum saturni), acetated ceruse (cerussa acetata), and superacetate of lead (plumbi superacetas).

Preparation.—Though directions are given in the Pharmacopoeia of its preparation, it is never made by the apothecary, but is procured in persons who manufacture it on a large scale. It is sometimes made by immersing lead in acetic acid. The metal attains oxygen from the air and combines with the acid. It may also be procured by dissolving carbonate of lead in acetic acid, filtering the solution, and evaporating so that it may crystallize. But it is almost exclusively obtained now by dissolving oxide of lead (litharge or massicot) acetic (pyroligneous) acid. This process is the one followed in the London Pharmacopoeia; where four pounds and two ounces of powdered charge are directed to be dissolved, by the aid of a gentle heat, in a mixture of four pints of acetic acid and four pints of distilled water. The solution is to be strained, and evaporated so that it may yield crystals. By this process, the oxide, in virtue of its affinity for acetic acid, combines with the latter, and forms a definite compound.

Properties.—The primary form of the crystals of this salt is the right-angled prism. Their taste is sweetish and astringent. In a dry, warm atmosphere they slightly effloresce. When heated they fuse, lose their water of crystallization, and, at a higher temperature, decomposed; yielding acetic acid, pyroacetic spirit (or acetone), bonic acid, inflammable gas, and water: the residuum is a mixture of lead and charcoal. Acetate of lead is soluble in both water and alcohol. The aqueous solution feebly reddens litmus, though it communicates a green colour to the juice of violets. A solution of the neutral acetate is partially decomposed by carbonic acid: a small quantity of carbonate of lead is precipitated, and a portion of acetic acid is set free, which protects the remaining solution from further change.

Characters.—When heated with sulphuric acid, the vapour of acetic acid is disengaged. Its solution is known to contain lead by the tests of this metal already mentioned (vide p. 503). If a small quantity of acetic acid be added to the solution, a current of carbonic acid occasions precipitation. The ordinary acetate of the shops usually throws down, as a white precipitate (carbonate of lead) with carbonic acid. When treated, it readily yields globules of metallic lead on the application of blowpipe flame.
Composition.—This salt, when properly prepared, has the following composition:

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<tr>
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<tbody>
<tr>
<td>Oxide of Lead</td>
<td>1</td>
<td>112</td>
<td>58.9</td>
<td>58.71</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>1</td>
<td>51</td>
<td>26.8</td>
<td>26.97</td>
</tr>
<tr>
<td>Water</td>
<td>3</td>
<td>27</td>
<td>14.3</td>
<td>14.32</td>
</tr>
</tbody>
</table>

Crystalline Acetate of Lead 1 ..... 190 ... 100.0 100.0

Purity.—It should be readily and completely soluble in water. Sulphuric acid, or sulphuretted hydrogen in excess, being added to the solution, to throw down the lead, the supernatant liquor should be completely volatilized by heat: any fixed residue is impurity.

Physiological Effects. (a.) On vegetables.—(Vide p. 506.)

(b.) On animals.—Orfila (Toxicol. Gén.) found that in large doses the acetate of lead acted on dogs as an irritant, and caused vomiting, pain, and death. When the action was slower, and absorption took place, an affection of the nervous system was observed, marked by difficult progression, and in some cases convulsive movements. The mucous membrane lining the alimentary canal was found whitened (owing to the chemical influence of the poison), and, where the action was more prolonged, reddened. Injected into the veins, or applied to wounds, it affects the nervous system. Schloepfer (quoted by Dr. Christison, p. 507) produced colica pietonum, paralysis, and convulsions, in dogs, by the repeated use of small doses. Dr. A. T. Thomson (Lond. Med. Gaz. x. 691) gave successively, one, two, three, and six drachms to a dog without any ill effect.

(c.) On man.—Applied to ulcers, muceous membranes, or other secreting surfaces, it acts as a desiccative and astrigent. It reacts chemically on the albumen of the secretions and of the living tissues, and forms therewith compounds, which are for the most part insoluble in water and acids (Dr. C. G. Mitscherlich, Brit. Ann. of Med. i. 204). Hence the difficulty with which this salt becomes absorbed. Some of its compounds with organic substances are, however, rendered soluble in water by acids (as the acetic, hydrochloric, and lactic). In large quantities, acetate of lead taken into the stomach acts as an irritant, and causes symptoms of inflammation of the stomach, viz. vomiting, burning in the gullet and stomach, and tenderness at the pit of the stomach; but these are usually accompanied with colica pietonum, and are not unfrequently followed by convulsions, coma, or local palsy (Christison, Treat. on Poisons, 3d edit. p. 512). Ten grains taken daily for seven days caused tightness of the breast, metallic taste, constriction of the throat, debility, sallow countenance, slow respiration and circulation, gums turgid and tender, ptyalism, tightness and numbness in the fingers and toes, no nausea, pains of the stomach and abdomen, bowels confined (Laidlaw, Lond. Med. Repos. N. S. vi. 292). The observations of Dr. A. T. Thomson and others (Van Swieten, Reynolds, Latham, Laidlaw, Daniell, Christison, &c.) have, however, shewn that injurious effects from the use of large doses are very rare. Dr. Christison has given eighteen grains daily for eight or ten days without any unpleasant symptoms whatever, except once or twice slight colic. Whenever this salt gives rise to any obvious effects, they are those of the plumbeous preparations in general, and which have been already described (p. 506). Its medicinal action, therefore, is sedative and astrigent.
USES.—Acetate of lead is administered internally to diminish the diameter of the capillary vessels, and lessen circulation, secretion, and exhalation. Thus we employ it in profuse discharges from the mucous membranes; as from the lungs, alimentary canal, and even the urino-genital membrane. In the mild cholera, so common in this country towards the end of summer, I have found acetate of lead in combination with opium most efficacious where the chalk mixture failed. I have used this combination in a few cases of malignant cholera, and in one or two with apparent benefit. In colliquative diarrhoea and chronic dysentery it occasionally proves serviceable. In phthisis it has been found beneficial, but only as a palliative, namely, to lessen the expectoration, check the night sweats, or stop the harassing diarrhoea. Dr. Latham (Med. Trans. Coll. Phys. v. 341) speaks most favourably of the use of sugar of lead and opium in checking purulent or semipurulent expectoration. Though I have repeatedly seen it diminish expectoration, I have generally found it fail in relieving the night sweats, though Fouquier supposed it to possess a specific power of checking them: they are more frequently benefited by diluted sulphuric acid. In sanguineous exhalations from the mucous membranes, as epistaxis, hæmoptysis, and hæmatemesis, and an uterine hæmorrhage, it is employed with the view of diminishing the calibre of the bleeding vessels, and thereby of stopping the discharge; and experience has fully established its utility (Reynolds, Trans. Coll. of Phys. London, iii. 217; Davies, Med. and Phys. Journ. Jan. 1808, p. 8; also, Mitchell, ibid. p. 69; Latham, op. cit.). It may be employed in both the active and passive states of hæmorrhage. It is usually given in combination with opium. It has been employed also as a remedy for mercurial salivation (Daniell, Lond. Med. Repos. N. S. vi. 308). It had already been applied for this affection in the form of gargle by Somme (Archiv. Gén. de Méd. i. 483). Unless care be taken to wash the mouth carefully after its use, it is apt to blacken the teeth. On the same principles that we administer it to check excessive mucous discharges, it has been employed to lessen the secretion of pus in extensive abscesses attended with hectic fever.

There are some other cases in which experience has shewn acetate of lead is occasionally serviceable, but in which we see no necessary connection between its obvious effects on the body and its remedial powers; as in epilepsy, chorea, intermittentes, &c.

As a topical remedy, we use acetate of lead as a sedative, astringent, and desiccative. An aqueous solution of it is applied to inflamed parts, or to secreting surfaces, to diminish profuse discharges. Thus we use it in phlegmonous inflammation, in ophthalmia, in ulcers with profuse discharges, in gonorrhœa, and gleet. In the sloughing and ulceration of the cornea which attend purulent and pustular ophthalmia, its use should be prohibited, as it forms a white compound which is deposited on the ulcer, to which it adheres tenaciously, and in the healing becomes permanently and indelibly imbedded in the structure of the cornea. The appearance produced by this cause cannot be mistaken: its chalky impervious opacity distinguishes it from the pearly semi-transparent structure of even the densest opacity produced by common ulceration (Dr. Jacob, Dubl. Hosp. Rep. v. 369). The white compound consists of oxide (acetate?) of lead, animal matter, much carbonate of lead, traces of phosphate, and chloride of the same metal (Dr. Apjohn, op. cit. p. 402).
Administration.—Acetate of lead is administered internally in doses of from one grain gradually increased to three, four, or more, even to eight or ten grains, repeated twice or thrice daily. Dr. A. T. Thomson advises its exhibition in diluted distilled vinegar, to prevent its change into carbonate, which renders it more apt to occasion colic. It is usually exhibited in the form of pill, frequently in combination with opium. Acetate of lead and opium react chemically on each other, and produce acetate of morphia and meconate, with a little sulphate of lead. Experience, however, has fully established the therapeutic value of the combination. Sulphuric acid (as in infusion of roses), sulphates (as of magnesia, and soda, and alum), phosphates, and carbonates, should be prohibited. Sulphuric acid, the sulphates, and phosphates, render it inert: the carbonates facilitate the production of colica pictorum. Common (especially spring) water, which contains sulphates, carbonates, and chlorides, is incompatible with this salt. The liquor ammoniæ acetatis is incompatible with it, on account of the carbonic acid usually diffused through this solution.

Ceratun Plumbi Acetatis, Ph. Lond.; Unguentum Plumbi Acetatis, Ph. Dubl. and Edinb. (Acetate of lead, powdered, 5ij.; white wax, 3ij.; olive oil, 3vij. M. Ph. Lond. The Dublin College mixes an ounce of the acetate of lead with a pound and a half of ointment of white wax. The Edinburgh College uses twenty parts of simple ointment and one part of acetate of lead in very fine powder.)—It is an excellent soothing application to irritable ulcers, painful excoriations, and blistered surfaces.

Antidote.—Vide Plumbum.

Liquor Plumbi Diacetatis.—Solution of Diacetate of Lead.

History.—This compound was known to Basil Valentine in the fifteenth century. It owes its reputation, as a medicine, principally to the praises bestowed on it by M. Gouard, in the latter end of the last century. He called it extract of Saturn (extractum Saturni). It is frequently termed Goulard's extract, or liquor plumbi subacetatis.

Preparation.—In the London Pharmacopoeia it is directed to be prepared by boiling together two pounds and three ounces of acetate of lead, one pound and four ounces of oxide of lead (litharge) rubbed to powder, and six pints of water; frequently stirring: when the liquor is cold, add as much distilled water as may be sufficient to measure with it six pints. The acetate of lead combines with an additional equivalent of oxide of lead, to form the diacetate. This process yields a uniform preparation.

In the Dublin Pharmacopoeia it is ordered to be prepared by boiling one part of semivitrified oxide of lead with twelve parts of distilled vinegar, until eleven parts of the fluid remain; and when the impurities have subsided, the liquid is to be filtered. The acetic acid of the distilled vinegar combines with the oxide of lead to form a subacetate of lead. This process is objectionable, since the strength of the solution depends on the strength of the vinegar, which is subject to variation.

Properties.—It is a transparent and colourless liquid. Prepared according to the London Pharmacopoeia, its specific gravity is 1.260:
according to the Dublin Pharmacopœia, it is 1:118. Its taste is sweet and astringent. By evaporation it yields crystals of the diacetate of lead, which, according to Dr. Barker, are flat rhomboidal prisms, with dihedral annulii.

Characteristics.—The presence of lead and of acetic acid in this solution may be known by the tests before mentioned (p. 515) for acetate of lead.

From the neutral acetate it is distinguished by the more abundant precipitate which it produces with carbonic acid, and by the copious precipitate which it affords with mucilage—an effect not produced with the neutral acetate. Solution of the diacetate of lead forms a precipitate with most vegetable colouring matters.

Composition.—This liquid is an aqueous solution of the diacetate of lead. The hydrated diacetate has, according to Dr. Thomson, the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide of Lead</td>
<td>2</td>
<td>224</td>
<td>61·37</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>1</td>
<td>51</td>
<td>13·97</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>90</td>
<td>24·66</td>
</tr>
</tbody>
</table>

Hydrated Diacetate of Lead. 1 . . . 365 . . . 100·00

Purity.—When this compound has been prepared with common sugar it has a brown colour.

Physiological Effects.—Its effects are analogous to the acetate. Dr. A. T. Thomson (Lond. Med. Gaz. v. 538; x. 693) asserts, from his experiments on animals, that it has more tendency to cause colic than the neutral acetate, because it is more readily converted into carbonate of lead. It is employed in medicine as a local astringent and sedative. Analysis is said to have resulted from its external use.

Uses.—It is used, when diluted, to promote the resolution of external inflammation, to check profuse discharges from suppurating, ulcerated, and mucous surfaces, and to alleviate local pains. Thus it is applied to parts affected with either phlegmonous or erysipelasous inflammation, to blisters, to inflamed tendons, aponeuroses, or absorbent glands; in ophthalmia, to contusions, sprains, burns, wounds, whether incised or ulcerated, to blistered surfaces, ulcers, abscesses, &c.

It is said to have been successful, internally, in hydrophobia.

Administration.—It is employed diluted with water, added to poultices, or mixed with fatty matters, and applied as an ointment.

Liquor Plumbi Diacetatis Dilutus, Ph. Lond. Plumbi subacetatis liquor compositus, Ph. Dub. (Solution of diacetate of lead, 15ss.; distilled water, Oj.; proof spirit, 5ij. M.)—This preparation is an imitation of the water of Saturn, or vegeto-mineral water of Goulard. It is commonly termed, in the shops, Goulard water. It should be transparent and colourless; but when prepared with common water it is more or less milky, owing to the formation of carbonate, sulphate, and chloride of lead. The small quantity of spirit employed can be of no service. The quantity of the solution of diacetate of lead employed in making Goulard water is much too small; it should be, at least, three times, and in some cases I have used six times, as much. I have never seen any ill effects from its use, though it is said to have become absorbed in some cases. The same objection applies to the use of this compound as to that of the neutral acetate in ulceration of the cornea (vide p. 517.)
Goulard water is used as a cooling, sedative, and astringent wash in the cases already enumerated for the Goulard's extract. A poultice, composed of crumb of bread, boiled in Goulard water, is sometimes a very useful application to phlegmons, painful wounds, irritable ulcers, &c. &c.

*Ceratum Plumbi Compositum*, Ph. Lond. (Solution of diaacetate of lead, \((\text{Pb}_2\text{O}_4\text{O}_2\text{HO})\); wax, \(\text{Pb}_3\text{O}_4\); olive oil, Oss.; camphor, \(\text{Pb}_4\text{O}_4\)).—This is the *cerate of Saturn* of M. Goulard, and is commonly called *Goulard's cerate*. It is employed as a dressing to wounds and ulcers, for the purpose of allaying irritation and appeasing pain. With the same views it is also applied to excoriated surfaces, burns, scalds, blistered surfaces, and irritable cutaneous affections. Opium is sometimes advantageously combined with it.

*Ceratum Saponis*, Ph. Lond.—This contains a subacetate of lead. It has been before described (p. 337).

*Emplastrum Plumbi.—Plaster of Lead.*

**History.**—This compound was known to the ancients: both Pliny (Hist. Nat. xxxiv. 53) and Celsus (De Medicina, lib. v. cap. xix.) give a formula for a plaster used by the Roman surgeons, which is almost identical with that for the officinal plaster of lead.

It is termed *emplastrum lythargyri* in the Dublin Pharmacopoeia, and is commonly sold in the shops as *diachylon* or *diachylum*.

**Preparation.**—In the London Pharmacopoeia it is directed to be prepared by mixing six pounds of oxide of lead (litharge), rubbed to a very fine powder; a gallon of olive oil; and two pints (\(3\times 1\)) of water. These are to be boiled together over a slow fire, constantly stirring, to a proper consistence.

In this process the oil becomes saponified, and converted, by the aid of the elements of water, into *glycerine, oleic acid, and margaric acid*. The glycerine remains in solution in the water, while the two fatty acids combine with the oxide of lead to form the oleo-margarate of lead or plaster of lead.—(For further particulars respecting the theory of saponification, vide p. 384).

The water used in this process serves two purposes; it moderates the heat, and facilitates the union of the acids with the oxide of lead.

**Properties.**—It is met with in the shops in cylindrical rolls, of a greyish or yellowish-white colour, brittle when cold, but softening and ultimately fusing by heat. It is insoluble in water, and nearly so in alcohol. It has no taste, but a slight though peculiar odour.

**Characteristics.**—When heated it fuses, then decomposes, gives off inflammable gas, and leaves a carbonaceous residue, which, when heated in a close vessel, yields globules of lead. Ether dissolves the oleate but not the margarate of lead.

**Composition.**—Berzelius (Traité de Chim. v. 373) says this compound is to be regarded as a tribasic salt: that is, as consisting of one equivalent of the fatty acids (oleic and margaric) and three of the oxide of lead.

**Effects and Uses.**—This plaster is employed in surgery, on account of its adhesiveness and the mildness of its local action; for it rarely excites irritation. It is used to keep the edges of wounds together in persons with delicate skins. Spread on calico it forms a good *strap-
ZINC.

521

Some for giving support and causing pressure in ulcers of the leg, — a most successful mode of treating them, and for which we are indebted to Mr. Baynton.

In pharmacy it serves as a basis for various other plasters.

Emplastrum Resinæ, Ph. Lond. Emplastrum Lithargyri cum Resina, Ph. Dubl. Emplastrum Resinosum, Ph. Ed. (Resin, Oss.; plaster of lead, Oij. M. Ph. Lond. The proportions used in the Dublin and Edinburgh Pharmacopeias are slightly different). — This is the common adhesive plaster (emplastrum adhesivum), and is kept in the shops ready spread. It is employed to retain the lips of wounds in contact, as in cuts, surgical operations, &c. It is more adhesive than lead plaster, but at the same time somewhat more irritating, and occasionally causes excoriation. It is sometimes employed as a strapping for dressing ulcers, on Baynton’s principles.

Emplastrum Saponis, Ph. Lond. and Dub. — The lead plaster is a constituent of the soap plaster already described (p. 338).

Unguentum Plumbi Compositum, Ph. Lond. (Prepared chalk, viij.; distilled vinegar, 3½v.; plaster of lead, lb. iij.; olive oil, Oj. Mix the chalk with the vinegar, and when the effervescence has ceased, add gradually the solution to the plaster and oil melted with a slow fire, and stir constantly until they are cooled). — By the action of the acetic acid on the chalk, an acetate of lime is procured, and carbonic acid evolved, and the acetate of lime is then mixed with lead plaster and oil. This compound is an imitation of Kirkland's neutral cerate, used as a dressing to indolent ulcers. It is employed by Mr. Higginbottom (Essay on the Use of Nitrate of Silver, 2d ed. p. 119), under the name of neutral ointment, as a defence for ulcers after the application of nitrate of silver.

Order 25. — Zinc and its Compounds.

Zincum.—Zinc.

History.—Although the ancients were acquainted with the method of converting copper into brass by means of an ore of zinc, yet they were unacquainted with metallic zinc, one of the constituents of this alloy. Albertus Magnus, who died in 1280, is the first who expressly mentions this metal.

It has various appellations, such as contrefeyn, golden marcasite, Indian tin (stannum indicum), spiautler, speltre or spelter (speltrum).

Natural History. — It occurs only in the mineral kingdom. It is found in the form of oxide (red zinc), of sulphuret (blende or black jack), of carbonate (calamine), of sulphate (white vitriol), of silicate (electric calamine), and aluminate (automalite or galmite).

Preparation. — It is obtained from the sulphuret, carbonate, and silicate. The sulphuret is roasted, by which part of the sulphur is expelled, and the metal oxidized: it is then mixed with some carbonaceous substance, introduced into an earthen crucible, the bottom of which is perforated by an iron tube which passes into a vessel of water situated in an apartment below. The zinc is reduced in the pot, sub-
limes, and passes through the tube, dropping into the water beneath. This is called distillation per decensum. Zinc is also procured from the carbonate and silicate of this metal, by treating it as above described for roasted blendc.

The zinc used in this country is principally imported in ingots and plates from Silesia, by way of Hamburg, Antwerp, Dantzic, &c. The only zinc-works at present in this country are at Macstag, near Margam, Glamorganshire.

Properties.—It is a bluish-white metal, of considerable lustre. It crystallizes in four-sided prisms and needles; its texture is lamellated and crystalline. Its sp. gr. is from 6·8 to 7·2. At common temperature it is tough; from 212° to 300° it is ductile and malleable, and may be readily rolled into thin leaves (sheet zinc); at 400° it is so soluble that it may be reduced to powder. It readily fuses, and, at a white heat, may be volatilized.

Characteristics.—It is soluble in dilute sulphuric acid, with the evolution of hydrogen gas. Ferrocyanide of potassium forms, in this solution, a gelatinous white precipitate (ferrocyanide of zinc): if iron be present the precipitate is bluish-white. If the liquid be neutral, hydro-sulphuric acid and the soluble hydrosulphates also occasion a white or yellowish-white precipitate (sulphuret of zinc). Alkalis and their carbonates likewise throw down white precipitates: that occasioned by the alkalies (oxide of zinc) is soluble in excess of alkali. The delicacy of these tests is, according to Devergie (Méd. Lég. ii. 787), as follows:—

<table>
<thead>
<tr>
<th>Degree of Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrocyanide of Potassium</td>
</tr>
<tr>
<td>Ammonia</td>
</tr>
<tr>
<td>Potash, or Carbonate of Ammonia</td>
</tr>
<tr>
<td>Carbonate of Potash, or Hydrosulphate of Ammonia</td>
</tr>
<tr>
<td>Hydrosulphuric Acid</td>
</tr>
</tbody>
</table>

Physiological Effects.—In the metallic state it is inert. The compounds of zinc are somewhat analogous, in their action on the system, to those of copper, silver, and bismuth, but are much less energetic. They act topically, according to their degree of concentration, as desiccatives, astringents, irritants, and caustics. Taken internally, they excite, more or less readily, nausea and vomiting, and in large doses operate as irritant and caustic poisons. They exercise a specific influence over the nervous system, though this is much less obvious than in the preparations of the other metals just referred to. The stupor and inactivity, mentioned by Orfila (Toxicol. Gén.), as being produced by the sulphate, are evidence of an affection of the nervous system. The antispasmodic power evinced by zinc, in certain diseases, can only be explained by referring it to the action of this metal on the nervous centres.

Uses.—As topical agents we employ the compounds of zinc as caustics, astringents, and desiccatives. Thus the chloride is used as a caustic, the sulphate and acetate as an astringent, and the oxide and carbonate as a desiccative.

Internally, the zincic compounds are administered in large doses to excite vomiting; in smaller doses as tonics and antispasmodics in intermittent diseases and chronic affections of the nervous system.
Zinc Oxide.—Oxide of Zinc.

History.—The oxide was first prepared by Hellot in 1735. It has received various names, some of them of a fantastic nature; as nihil lum, lana philosophica, pompholyx, flowers or calx of zinc (flores seu alx zinci).

Natural History.—Oxide of zinc is found in America, mixed or combined with the sesquioxide of manganese, and constituting the red oxide of zinc of the mineralogist. It is also found in various localities, in combination with carbonic, sulphuric, or silicic acid.

Preparation.—In the Dublin Pharmacopoeia it is directed to be obtained by throwing zinc into a deep crucible heated to whiteness, and immediately inverting (loosely) a second crucible over the first one, so as not to exclude the air. The metal attracts oxygen from the air, and the oxide thus formed is deposited on the sides of the crucible.

In the London Pharmacopoeia it is ordered to be prepared by mixing a pound of sulphate of zinc dissolved in twelve pints of distilled water, with six ounces and a half of sesquicarbonate of ammonia, also dissolved in twelve pints of distilled water. The precipitate is to be frequently washed and ignited during two hours.

In this process double decomposition takes place; sulphate of ammonia is formed in solution, and carbonate of zinc precipitates. A portion of the carbonic acid of the sesquicarbonate of ammonia escapes.

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Sesquicarb.</td>
<td>2 eq. Carbonic Acid 22</td>
</tr>
<tr>
<td>Ammonia... 100</td>
<td>2 eq. Carbonic Acid 44</td>
</tr>
<tr>
<td>1 eq. Sulphate of Zinc</td>
<td>2 eq. Sulph. Amm........ 114</td>
</tr>
<tr>
<td>Zinc...... 160</td>
<td>2 eq. Oxide of Zinc 80</td>
</tr>
</tbody>
</table>

The carbonate of zinc is decomposed by the subsequent ignition, and the carbonic acid expelled, leaving the oxide.

Properties.—The primary form of the crystallized native oxide of zinc (containing the oxides of iron and manganese) is a right rhombic prism.

The artificial oxide met with in the shops is a white, or, when ignited, yellowish-white, tasteless, odourless powder. It is fusible, forming a yellow glass, and at a white heat is volatilized. When heated with charcoal it is readily reduced. It is insoluble in water, but readily dissolves in most acids and in alkalies. It forms two classes of salts: one (the zinccic salts), in which it is the base; a second (zincates), in which it acts the part of an acid.

Characteristics.—It dissolves in dilute sulphuric acid. The characteristics of the solution have been already detailed (p. 521).

Composition.—Oxide of zinc has the following composition:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>1</td>
<td>32</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>8</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Oxide of Zinc</td>
<td>1</td>
<td>40</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

The oxide of the shops is usually the hydrated oxide of zinc, and consists of 1 eq. oxide of zinc = 40/1 eq. water = 9.

Purity.—Pure oxide of zinc is completely and readily soluble in dilute sulphuric acid, without effervescence: the precipitate produced in this solution, by caustic ammonia or caustic potash, should be com
pletely soluble in an excess of the precipitant. Oxide of cadmium has been sometimes found in it, and was once mistaken for arsenious acid (Thomson's *Hist. of Chem.* ii. 219). Iron and manganese (Liebig) are sometimes present in oxide of zinc, and communicate a yellow tinge to it.

**Physiological Effects.** (a) *On animals.*—Orfila (*Toxicol. Gén.*) gave from three to six drachms of it to small and weak dogs; they were attacked with vomitings, without suffering much.

(b) *On man.*—Applied to ulcerated or other secreting surfaces, it acts as a desiccating and astringent substance. On account of its insolubility, the absorption of it must be very slow. Taken into the stomach in large doses, it acts as a slight irritant, and provokes vomiting, and sometimes purging. It is said to have also caused occasional giddiness and temporary inebriation. In small doses it may be taken for a considerable period without causing any obvious effects. Sometimes, under its employment, certain affections of the nervous system (as epilepsy, chorea, &c.) subside; from which we infer that it exercises some specific influence over this system; and it is, therefore, termed tonic, antispasmodic, and sedative. But the nature of its influence is not very obvious, and is inferred rather from analogy than observation. By long-continued use it acts as a slow poison, and produces tabes sicca. A gentleman, for the cure of epilepsy, took daily, at an average, twenty grains of oxide till he consumed 3246 grains, which must have taken him about five months. At the end of this time he was found of a pale, earthy hue, wasted away, and almost idiotical: his tongue was thickly coated, the bowels were constipated, the inferior extremities cold and odematous, the abdomen tumid, the superior extremities cold and shrivelled, and their skin dry, like parchment; the pulse was about sixty, thin, and scarcely perceptible. Under the use of purgatives, a light nutritive diet, with tonic and diuretic medicines, he rapidly recovered, but he remained subject to epileptic attacks (*Brit. and For. Med. Rev.* July 1838, p. 221).

**Uses.**—*Internally* it has been commended in some spasmodic diseases, viz. epilepsy, chorea, hysteria, catalepsy, and hooping-cough; and in some painful affections, as neuralgia and gastrodynia. Though occasionally serviceable in some of these maladies, it has so frequently failed that practitioners have ceased to place much confidence in it.

*Externally* it is employed in the form of powder, or lotion, or ointment. As a *dusting powder* it is useful, by its mild, absorbent, and desiccative properties, and is applied to impetiginous and other chronic diseases of the skin, attended with profuse secretion. It is also used to allay or prevent excoriation in children and bedridden persons, and to remove chaps and cracks of the nipples. In painful ulcers, with copious discharge, it is not unfrequently beneficial by its desiccative and sedative properties. *Diffused through water or a mucilaginous solution* (in the proportion of two drachms of the oxide to six or eight ounces of liquid), it is occasionally useful in chronic ophthalmia, especially *ophthalmitis tarsi*. Sommé (*Archiv. Gén. de Méd.* i. 486) employed an injection composed of half an ounce of oxide and two pints of water in gonorrhoea and leucorrhoea, with success.

**Administration.**—Internally it is administered in the form of pill or powder, in doses of from two or three grains gradually increased to eight, ten, or more.
Unguentum Zincli, Ph. Lond. Unguentum Zincli Oxydi, Ph. Dub. and Ed. (Oxide of zinc, 3; lard, 3vj. M. Ph. Lond. The Edinburgh College substitutes simple liniment for lard; the Dublin College uses eight parts of ointment of white wax to one part of the oxide).—This compound is employed as a mild drying ointment in porrigo, impetigo, and other skin diseases attended with profuse discharges, after extensive burns, blisters, sinapisms, &c.; to painful ulcers with excessive secretion, to chronic inflammation of the eye, &c.

Zinci Oxydum Impurum, Ph. Ed.—This substance is known in the shops under the name of tutty (tutilus seu tutilia), or furnace cadmia cadnia fornacem seu factitia). It is found in the chimney of the furnace in which zinc ores are roasted, or in which zineiferous lead ores are melted. When prepared by levigation and elutriation it is called prepared tutty (oxidum zincli impurum preparatum, Ph. Ed.; tutia preparata.) It is applied as a dusting powder, or as a cooling ointment (unguentum oxidii zincli impuri, Ph. Ed.; composed of simple liniment, 6 parts; prepared impure oxide of zinc, 1 part, M.), to exoriated surfaces.

Zin'ci Chlo'ridum.—Chlo'ride of Zinc.

History.—This compound, which has been long known to chemists, was first introduced into medicine by Papenguth (Russ. Samml. f. Naturw. u. Heilk. H. i. S. 79, quoted by Riehler, Ausf. Arzneim. iv. 526), and subsequently has been recommended by Professor Haneke of Breslau, (Rust’s Magazin, 1826, Bd. 22, S. 373), and by Dr. Canquoin, of Paris (Dr. Alex. Ure, Lond. Med. Gaz. xvii. 391). It is termed muriate, hydrochlorate, or butter of zinc.

Preparation.—The easiest and cheapest method of obtaining it is by dissolving zinc, or its oxide, in hydrochloric acid, evaporating to dryness, and fusing in a glass vessel with a narrow mouth, as a Florence flask.

Properties.—It is a whitish grey semi-transparent mass, having the softness of wax. It is soluble in water, alcohol, and ether. It is fusible, and at a strong heat may be sublimed and crystallized in needles. It is very deliquescent. It unites with both albumen and gelatine to form diffusely soluble compounds, and hence it occasions precipitates with liquids containing these principles in solution.

Characteristics.—Dissolved in water it may be recognised to be a chloride by nitrate of silver (vide 105). That zine is the base of the salt may be shewn by the tests already mentioned for this metal (p. 521).

Composition.—Its composition is as follows:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
<th>J. Davy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>1</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1</td>
<td>36</td>
<td>53</td>
</tr>
<tr>
<td>Chloride of Zinc</td>
<td>1</td>
<td>68</td>
<td>100</td>
</tr>
</tbody>
</table>

Physiological Effects.—Its local action on living tissues is that of a caustic or escharotic, depending partly on its affinity for albumen and gelatine; so that when placed in contact with living parts into whose composition these organic compounds enter, the chloride exercising its affinity, first destroys the life of the part, and then unites with thealbuminous and gelatinous matters present, and forms thus an eschar. Other chemical changes of a comparatively unimportant nature are also effected: thus, various salts found in the solids or liquids of the part
may be decomposed. For example, when the chloride is applied to a cancerous sore, it decomposes the carbonate and hydro sulphuret of ammonia found in the secretion of the sore. The effects produced by the application of chloride of zinc are the following:—Soon after it has been applied, a sensation of warmth is felt in the part, quickly followed by violent burning pain, which continues for seven or eight hours; that is, until the parts in contact with the chloride are dead. A white eschar is now observed, which usually separates in from eight to twelve days. Unless used in the neighbourhood of loose cellular tissue, there is rarely much swelling.

As a caustic, chloride of zinc is not inferior in power to chloride of antimony; nay, Vogt (Pharmakodynamik. i. 363, 2te Aufl.) says, it appears to him to be more powerful, and to penetrate deeper. It decomposes the organic tissues as quickly as the nitrate of silver, but excites more burning, and for a longer time, owing to its action extending to parts placed more deeply, for it is well known that the operation of the nitrate is confined to superficial parts. Both Vogt and Canquoin agree that chloride of zinc, besides corroding the parts with which it is in contact, exercises an influence over the vital actions of neighbouring parts. To this circumstance is owing, in great part, the efficacy of the chloride in various diseases in which it has been applied, and the healthy appearance of the sore after the separation of the eschar. There is no danger of any constitutional disorder arising from the absorption of the poison, as is the case with the arsenical and mercurial caustics.

Taken internally, in large doses, it acts as an irritant or caustic poison, and affects the nervous system. Thus it produces a burning sensation in the stomach, nausea, vomiting, anxiety, short breathing, small quick pulse, cold sweats, fainting, and convulsions. Taken in very small doses, no obvious effects are produced, except sometimes the amelioration of certain diseases. It is supposed in these cases to influence the nervous system.

Uses.—Internally chloride of zinc has been given in small but gradually increased doses in scrofula, epilepsy, chorea, and (in combination with hydrocyanic acid) in neuralgia of the face.

Commonly, however, it is employed externally: thus Papenguth used a dilute solution of it as a lotion in fistulous ulcers of a scrofulous nature. As a caustic it has been applied by Professor Hanke and Dr. Canquoin to produce an issue, to destroy navi materni, and as an application to parts affected with malignant diseases, such as fungus hematodes and cancer, or to other intractable forms of disease, such as old syphilite or scrofulous ulcers. The benefit is supposed not to depend merely on the escharotic effect, but on the chloride inducing a new action in the surrounding parts.

Administration.—Internally, it may be given in doses of one or two grains. Hufeland recommends it to be taken dissolved in ether; his formula for the ether zinci, as it is called, is the following:—g. Zinci Chlor. 3ss.; Alcoholis, 3j.; Ætheris Sulph. 3j. Post aliquot dies deanta. The dose of this solution is from four to eight drops, taken twice daily.

Externally it has been used as a lotion, composed of two grains of the chloride and an ounce of water; or in the form of paste: this may be composed of one part of chloride of zinc, and from two to four parts of wheaten flour.
Zin'ci Sul'phas.—**Sulphate of Zinc.**

**History.**—This salt is said by Schwartz (Pharm. Tabell. 2° Ausg. 79), to have been known towards the end of the 13th, or at the commencement of the 14th century; but Beckmann affirms it was not known before the middle of the 16th century (Hist. of Invent. iii. 85). It has ad various names, as *sal vitrioli*, *white vitriol*, and Gilla *Theophrasti.*

**Natural History.**—It occurs native at Rammelsberg, near Goslar, in the Harz; at Holywell, in Flintshire; and other places.

**Preparation.**—It is readily prepared by dissolving zinc in diluted sulphuric acid. The proportions, directed to be used in the London Pharmacopoeia, are five ounces of zinc and two pints of diluted sulphuric acid. The solution is to be filtered, evaporated, and crystallized. In this process 1 equivalent or 9 parts of water are decomposed, an equivalent or 1 part of hydrogen escapes, while an equivalent or 8 parts of oxygen unite with 1 equivalent or 32 parts of zinc, to form equivalent or 40 parts of the oxide, which, with 1 equivalent or 30 parts of sulphuric acid, form 1 equivalent or 80 parts of the sulphate. The zinc and the oxide thus formed combines with some sulphuric acid to form the sulphate.

<table>
<thead>
<tr>
<th>REAGENTS</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Water 91 eq. Hydrogen 1</td>
<td>1 eq. Hydrogen ..........1</td>
</tr>
<tr>
<td>1 eq. Zinc ..........32 1 eq. Ox. Zinc 40</td>
<td>1 eq. Sulphate of Zinc .. 80</td>
</tr>
<tr>
<td>1 eq. Sulphuric Acid ......40</td>
<td></td>
</tr>
</tbody>
</table>

By roasting blende (sulphuret of zinc) in reveratory furnaces an impure sulphate is obtained, which is lixiviated, and the solution concentrated by evaporation, so that on cooling it forms a crystalline mass resembling lump sugar. This is distinguished among druggists by the name of *white vitriol*, a term which they confine to this commoner kind of sulphate. This impure salt contains iron, and usually copper and lead.

**Properties.**—The primary form of the crystals of sulphate of zinc is the right rhombic prism; they are transparent and colourless, and have a metallic astringent taste. They are soluble in 2.56 times their weight of cold water, and less than their own weight of boiling water. They are insoluble in alcohol. In dry and warm air they effloresce. When heated they undergo the watery fusion; and if the liquid be rapidly cooled, it congeals into a granular, crystalline, white mass: if the heat be continued the salt becomes anhydrous, and, at an intense heat, is decomposed, leaving a residue of zinc.

**Characteristics.**—That this salt is a sulphate, is proved by the action of chloride of barium on it; a white precipitate is produced, insoluble in nitric acid. Acetate of lead also occasions a white precipitate. The presence of oxide of zinc in the solution is recognized by the tests already mentioned (p. 999.)

**Composition.**—This salt has the following composition:

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide of Zinc</td>
<td>1</td>
<td>40</td>
<td>28</td>
<td>32·585</td>
<td>{ } 55·24</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>28</td>
<td>30·965</td>
<td>{ } 44·76</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
<td>63</td>
<td>44</td>
<td>36·450</td>
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| Crystallized Sulphate of Zinc | 143 | 100 | 100·000 | 100·00 |

**Purity.**—Ammonia added to a solution of sulphate of zinc throws down the hydrated oxide of zinc; excess of ammonia re-dissolves the
oxide, and forms a colourless solution. If any oxide of iron or magnesia be present it remains undissolved; while any oxide of copper would form an azure blue solution. Arsenic or cadmium may be detected by adding excess of sulphuric acid to the solution of the sulphate, and then passing a stream of hydro sulphuric acid through it: the arsenium and cadmium are thrown down in the form of sulphurets. The impure sulphate called white vitriol is in irregular masses, here and there stained yellow with the iron.

**Physiological Effects.**—In small and repeated doses it acts as an astringent on the alimentary canal, checks secretion, and promotes a constipated condition of the bowels. It exercises a specific influence over the nervous system; manifested by its power of removing certain spasmodic affections: hence it is reputed antispasmodic. To the same influence is to be referred its power of preventing the recurrence of intermittent maladies, from which it has principally derived its denomination of a tonic. Its astringent effect is not confined to the bowels, but is manifested in the pulmonary and urethral mucous membranes, the secretions from which it diminishes: hence the advantage of its use in catarrhal affections of these parts. It does not appear to possess any power of checking cutaneous exhalation.

In full medicinal doses it is a powerful but safe emetic; it excites speedy vomiting without giving rise to that distressing nausea occasioned by emetic tartar, though this statement is not in accordance with the experience of Dr. Cullen (Treat. of the Mat. Med.), who observes that "in order to render its effects certain, the dose must generally be large; and if this is not thrown out again immediately it is apt to continue a disagreeable nausea, or even a vomiting, longer than is necessary." But this observation does not agree with the experience of other practitioners.

In excessive doses it acts as an irritant poison, causing vomiting, purging, coldness of the extremities, and fluttering pulse.

The local action of it is that of an astringent and desiccant, and in a concentrated form it is a powerful irritant and caustic. Its external use is said to have been found fatal in one case, by causing vomiting, purging, and convulsions (Christison, op. cit. p. 468).

**Uses.**—As an emetic it is almost exclusively employed in poisoning, especially by narcoties. In these cases it is the best evacuant we can administer, on account of its prompt action. As an internal astringent it is administered in chronic dysentery (Impey, Lond. Med. and Phys. Journ. ix. 55, 1803) and diarrhoea, in chronic bronchial affections attended with profuse secretion, and in gleet and leucorrhœa. In the latter cases it is usually associated with terebinthinate medicines, and is sometimes decidedly beneficial. As an antispasmodic it has been employed with occasional success in epilepsy, chorea, hysteria, spasmodic asthma, and hooping-cough. I have little faith in its efficacy in any of these cases. As a tonic it has been sometimes serviceable in agues, but it is far inferior to sulphate of quinia or arsenious acid.

As a topical astringent sulphate of zine is most extensively employed. We use its aqueous solution as a collyrium in chronic ophthalmia, as a wash for ulcers attended with profuse discharge, or with loose flabby granulations; as a gargle in ulcerations of the mouth, though I have found it for this purpose much inferior to a solution of sulphate of copper; as a lotion for chronic skin diseases; and as an injection in gleet and leucorrhœa.
ACETATE OF ZINC.

Administration.—As an emetic the dose should be from ten to twenty grains; as a tonic, antispasmodic, or expectorant, from one to five grains. For external use, solutions are made of various strengths. Half a grain of the sulphate to an ounce of water is the weakest. The strongest if ever knew employed consisted of a drachm of sulphate dissolved in an ounce of water: it was used with success as an injection in gleet. But solutions of this strength must be applied with great caution, as they are dangerous.

Solutio Sulphatis Zinci, Ph. Ed. (Sulphate of zinc, gr. xvj.; water, 3viij.; diluted sulphuric acid, gtt. xvj. M.)—This formula might be very properly omitted.

Antidotes.—Promote the evacuation of the poison by demulcents. Afterwards allay hyperemesis by opium, blood-letting, and the usual antiphlogistic regimen. Vegetable astringents have been advised.

Zincii Acetas.—Acetate of Zinc.

History.—This salt was discovered by Glauber.

Preparation.—It may be procured by dissolving oxide of zinc in acetic acid, and crystallizing the saturated solution; or it may be readily obtained by double decomposition: 143 grains of crystallized sulphate of zinc, dissolved in water, and mixed with 190 grains of the acetate of lead, in solution, will produce 152 grains of sulphate of lead, which, being insoluble, precipitates, while 91 grains of the anhydrous acetate of zinc (equal to 154 grains of the crystallized acetate) are left in solution: or it may be procured by immersing a piece of zinc in a solution of acetate of lead until the liquid forms a white precipitate with hydro-sulphuric acid. In this process the lead is reduced to the metallic state (forming the arbor Saturni or lead tree), while the zinc replaces it in solution.

Properties.—It usually crystallizes in rhomboidal plates, having a pearly or silky lustre, closely resembling talc. The primary form of the crystals is the oblique rhombic prism. The salt is odourless, but has a bitter metallic taste. It dissolves readily in water, and is slightly efflorescent.

Characteristics.—When heated it fuses, and gives out an inflammable vapour, having the odour of acetic acid. When sulphuric acid is added to the salt, the vapour of acetic acid is evolved: this is easily recognized by its odour. These characteristics show it to be an acetate. That it is a zincic salt is proved by the tests before mentioned for a solution of this salt (p. 522).

Composition.—Its composition is, according to Dr. Thomson, as follows:

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<th></th>
<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
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<tbody>
<tr>
<td>Oxide of Zinc</td>
<td>1</td>
<td>40</td>
<td>25·97</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>1</td>
<td>51</td>
<td>33·11</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
<td>63</td>
<td>40·90</td>
</tr>
</tbody>
</table>

| Crystallized Acetate of Zinc | 1   | 154 | 99·98 |

Physiological Effects.—Its effects are analogous to, though milder than, the sulphate of zinc, but more energetic than the oxide. Its local action is astringent. Taken internally, in small doses, it acts as a tonic
and antispasmodic; large doses occasion vomiting and purging. Devaux and Dejaer (Orfila, Toxicol. Gén.) deny that it is a poison, even in large doses.

Uses.—It is rarely administered internally; but is applicable as an emetic, tonic, and antispasmodic, in the same cases in which the oxide or sulphate of zinc is employed.

As a topical remedy, it is used on account of its astringent qualities in chronic ophthalmia, gleet, and leucorrhœa. In the latter stages of gonorrhœa I have found it far more successful than the sulphate. Its beneficial effects were first described by the late Dr. Wm. Henry, of Manchester (Lond. Med. and Phys. Jour. ix. 53, 1803). Sir A. Cooper (Lancet, iii. 199) recommends, as the best injection which can be used in the third week of gonorrhœa, a mixture of six grains of sulphate of zinc and four ounces of liquor plumbi subacetatis dilutus. Of course double decomposition takes place, and the active ingredient is the acetate of zinc.

Administration.—When exhibited internally, as a tonic or antispasmodic, the dose is one or two grains gradually increased. As an emetic the dose is five to ten grains: its operation is very safe. As a lotion or injection it is employed in the form of aqueous solution, containing two or three or more grains of the salt to an ounce of water.

Solutio Acetatis Zinci, Ph. Edinb. (Sulphate of zinc, 5; acetate of lead, 9iv.; distilled water, 3xx. [by weight]. Dissolve the salts separately, each in ten ounces of the water. Mix the solutions, and when the precipitate has subsided, filter the liquor.)—Double decomposition is effected, sulphate of lead falls down, and acetate of zinc remains in solution. Each fluidounce contains three grains of the acetate. Used as an injection in gonorrhœa.

Zinci Acetatis Tinctura, Ph. Dubl. (Sulphate of zinc; acetate of potash, 1 in one part. Triturate them together, and add sixteen parts of rectified spirit; macerate for a week, with occasional agitation, and filter through paper.)—Here also we have double decomposition: sulphate of potash and acetate of zinc are formed. The first is precipitated, being insoluble in spirit, the second remains in solution. One drachm contains a quantity of acetate of zinc equal to about four grains of the crystallized acetate. When diluted with water, it is used as a collyrium and injection.

Zin'ci Car'bonas.—Car'bonate of Zinc.

History.—The native carbonate of zinc was perhaps known to the ancients, though they were unacquainted with its nature. The term calamine is applied both to the native carbonate and native silicate of zinc: the latter is termed by way of distinction electric calamine.

Natural History.—Native carbonate of zinc (calamine) is found in great abundance in several parts of England (in the counties of Somerset, Derby, Durham, &c.), as well as in various parts of the continent of Europe (in Carinthia, Hungary, Silesia, &c.) It occurs crystallized or in compact or earthy masses. Its colour varies, being more or less grey, yellow, or brown. Its sp. gr. is 4·2 to 4·5.

Preparation.—Calamine (calamina), or the impure carbonate of zinc (carbonas zinci impura, Ph. Lond.) is directed to be calcined, in order to make it pulverizable. But in this process water and more or less of the
carbonic acid is expelled. It is then reduced to a very fine powder (usually in mills), and is afterwards submitted to the process of elutriation. By this means we obtain prepared calamine (calamina preparata, Ph. Lond.; Zinci carbonas impurum preparatum, Ph. Dubl.)

Properties.—Prepared calamine is met with in the shops in the form of a heavy pinkish or flesh-coloured powder, or made up into little masses. When pure, it dissolves in nitric, hydrochloric, or sulphuric acid, with effervescence. Various impurities mixed with calamine are insoluble in these acids.

Characteristics.—The effervescence with the mineral acids shews calamine to be a carbonate. The presence of zinc in the solution is determined by the tests before mentioned for this metal (p. 522). The action of these tests, however, is more or less impeded by the presence of foreign matters in calamine.

Composition.—Carbonate of zinc has the following composition:

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<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
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<tbody>
<tr>
<td>Oxide of Zinc</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>1</td>
<td>22</td>
</tr>
</tbody>
</table>

Impurities.—The substance sold in the shops as prepared calamine frequently contains only traces of zinc. If hydrochloric acid be poured on it, effervescence (owing to the escape of carbonic and hydrosulphuric acids) takes place, and a portion is dissolved; but the greater part remains undissolved. Mr. Brett (Lond. Med. Gaz. xx. 72) found from 78 to 87·5 per cent. of sulphate of baryta. The remainder of the powder consisted of oxide of iron, carbonate of lime, lead (sulphuret of ?), and mere traces of zinc.

Physiological Effects.—Pure carbonate of zinc is probably similar in its action to the oxide.

Uses.—Calamine is employed as a dusting powder for children, and as a mild desiccant and astringent in excoriations, superficial ulceration, &c.

Ceratum Calaminæ, Ph. Lond.; Unguentum calamine, Ph. Dubl.; Ceratum Carbonatis Zinci Impuri, Ph. Ed. (Calamine; wax, $\frac{1}{3}$ lb. ss.; olive oil, $f_{3}xvj$. Add the calamine to the melted wax and oil when they begin to thicken, Ph. Lond. The Edinburgh College uses one part of carbonate to five of lard. The Dublin College uses one pound of carbonate and five pounds of ointment of yellow wax.) This is commonly called Turner’s Cerate, or the Ceratum epuloticum. It is an excellent assecicative and astringent application (when prepared with good calamine) to burns, scalds, excoriations, superficial ulcerations, &c.

Zinc Cyanidum.—Cyanide of Zinc.

History.—This salt, sometimes called hydrocyanate or cyanuret of zinc, has been introduced, by the German physicians, as a substitute for hydrocyanic acid.

Preparation.—It is prepared by adding recently-made oxide of zinc to hydrocyanic acid; or by adding a solution of sulphate of zinc to a solution of cyanide of potassium.
Properties.—Cyanide of zinc is a white powder, insoluble in water or alcohol.

Characters.—If a strong mineral acid be added to it, hydrocyanic acid is developed, and a soluble salt of zinc obtained. The latter is recognized by the tests before mentioned for a solution of zinc (p. 522).

Composition.—Its composition is as follows:

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<th>Eq.</th>
<th>Eq. Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>1</td>
<td>32</td>
<td>55.2</td>
</tr>
<tr>
<td>Cyanogen</td>
<td>1</td>
<td>26</td>
<td>44.8</td>
</tr>
<tr>
<td>Cyanide of Zinc</td>
<td>1</td>
<td>58</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Physiological Effects.—Its effects have not been carefully ascertained, but they are supposed to be similar to those of hydrocyanic acid.

Uses.—It has been used principally in affections of the nervous system, as epilepsy, hysteria, and chorea. It has also been employed in cardialgia and cramps of the stomach, and as an anthelmintic in children.

Administration.—We may give it in doses of from a quarter of a grain to a grain and a half three times a day. It may be taken in the form of powder mixed with calcined magnesia.

Order 26.—Iron and its Compounds.

Fer'rum.—I'ron.

History.—This metal (called by the alchemists Mars) was known in the most ancient times. It was employed medicinally at a very early period, namely, above 3200 years ago. Indeed, it appears to have been the first mineral used internally; and a curious anecdote is given of its introduction into medicine. Melampus (a shepherd supposed to possess supernatural powers) being applied to by Iphicles, son of Philacus, for a remedy against impotence, slaughtered two bulls, the intestines of which he cut to pieces, in order to attract birds to an augury. Among the animals which came to the feast was a vulture, from whom Melampus pretended to learn that his patient, when a boy, had stuck a knife wet with the blood of some rams into a consecrated chestnut-tree, and that the bark had subsequently enveloped it. The vulture also indicated the remedy, namely, to procure the knife, scrape off the rust, and drink it in wine, for the space of ten days, by which time Iphicles would be lusty, and capable of begetting children. The advice thus given by Melampus is said to have been followed by the young prince with the most perfect success! (Le Clerc, Hist. de la Médecine.)

Natural History.—Iron is met with in both kingdoms of nature.

(a.) In the inorganic kingdom.—Few minerals are free from iron. It is found in the metallic state (native iron), in combination with oxygen (hematite, micaceous iron, brown iron stone, and magnetic iron ore), with sulphur (iron pyrites, and magnetic pyrites), with chlorine (pyromalite), with oxygen and an acid (carbonate, phosphate, sulphate, arseniate, tungstate, tantalate, titaniate, chromate, oxalate, and silicate.)

(b.) In the organic kingdom.—It occurs in the ashes of most plants, and in the blood and some other parts of animals.

Extraction.—In Sweden, iron is extracted from magnetic iron ore and micaceous iron: in England, principally from clay iron ore (carbonate of iron.)
Clay iron ore (technically called mine) is burned with coal in large heaps, by which it loses carbonic acid, water, and sulphur. It is then smelted with a flux (in South Wales this is limestone; in the forest of Dean, clay;) and coke. The smelted iron is run into moulds, and is then called cast iron (ferrum fusum), or pig iron. This contains carbon, oxygen, silicon, and often sulphur and phosphorus. To separate these, it is submitted to several processes (called refining, puddling, and welding,) by which it is converted into wrought iron (ferrum cusum), (Manufacture of Iron, in the Library of Useful Knowledge; also, Treatise on Iron and Steel, in Lardner's Cyclopaedia).

Properties.—The primary form of the crystals of native iron is the regular octahedron. Pure iron has a whitish grey colour, or, according to Berzelius, is almost silver white. When polished it has much brilliancy: its taste is peculiar and styptic; when rubbed it becomes odorous. Its ductility and tenacity are great; its malleability comparatively small. Its sp. gr. is 7.878, but diminishes by rolling or drawing. It is attracted by the magnet, and several of its compounds are capable of becoming permanent magnets; but pure iron retains its magnetic property for a short time only. It requires a very intense heat to fuse it; and it is not volatile at any known temperature; while in the softened state, previous to melting, it is capable of being welded. Its equivalent or atomic weight is 28.

Characteristics.—Iron readily dissolves in diluted sulphuric acid, with the evolution of hydrogen gas. The solution contains the protosulphate of iron, and produces, on the addition of caustic potash or soda, a greenish-white precipitate (the hydrated protoxide): this precipitate, by exposure to the air, attracts oxygen, and is converted into the red or sesquioxide. Auro-chloride of sodium forms a purple precipitate with the protosalts of iron. By boiling the solution with a little nitric acid, we obtain a persulphate of iron, recognized by ferrocyanide of potassium causing a blue precipitate; sulphoammoniac or meconic acid, a red colour; gallic or tannic acid, or infusion of galls, a purple or bluish black; and succinate, or benzoate of ammonia, a yellowish precipitate.

Physiological Effects. (a.) Of the metallic iron.—Iron is probably inert so long as it retains its metallic form, but it readily oxidizes in the alimentary canal, and thereby acquires medicinal power. As acids promote this chemical change, acid wines and fruits assist in rendering the metal active, while alkalies and their carbonates have an opposite effect. The oxidizement of the iron is attended with the evolution of hydrogen gas, which gives rise to unpleasant eructations. If sulphur be taken along with iron, hydrosulphuric acid is developed. Like the ferruginous preparations generally, the internal employment of iron causes blackening of the stools. The nature of the effects produced by oxide of iron formed in the alimentary canal will be best examined hereafter, under the head of ferruginous preparations. I may, however, remark here, that it is one of the few metals which by oxidizement is not rendered more or less poisonous.

(b.) Of the ferruginous compounds. a. On vegetables.—Most of the compounds of iron do not appear to be hurtful to plants: at least this is the case with the oxides (Decandolle, Phys. Vég. 1387.) The sulphate, however, is said to be injurious (vide p. 551.)

b. On animals.—The effects of the ferruginous compounds on animals generally are similar to those on man. It is stated that in animals to
whom iron has been given for a considerable time, the spleen has been found smaller, harder, and denser—an effect which is supposed to be owing to the increased contractile power experienced by the veins of the abdomen. The liver is also said to have been affected in a similar manner, though in a somewhat slighter degree.

γ. On man.—The local effects of the sulphate and chloride of iron are those of irritants, and these preparations accordingly rank among poisons; but they are not equal in power to the mercurial or cupreous salts. Most of the ferruginous preparations are astringent; that is, they constrict the parts with which they are in contact, and thereby diminish secretions and check sanguineous discharges. Thus, when swallowed, they repress the secretions and exhalation of the gastro-intestinal membrane, and thereby render the alvine evacuations more solid, and even occasion costiveness. The sulphate and chloride of iron are the most powerful of the ferruginous astringents. Administered in large quantities, or when the alimentary canal is in an irritable condition, all the compounds of iron are capable of exciting heat, weight, and uneasiness at the praecordia, nausea, and even vomiting, and sometimes purging.

The constitutional or remote effects of the chalybeates are principally observed in the alteration induced in the actions of the vascular and muscular systems, and are best seen in that state of the system denominated anæmia, or more properly hypæmia, in which both the quantity and quality of the blood appear defective. We have a good illustration of this state in chlorotic patients. The skin appears pale and almost exsanguineous, the cellular tissue is oedematous, and, after death, the larger vessels as well as the capillaries are found to be imperfectly supplied with blood. Patients with this condition of system are affected with great feebleness, loss of appetite, and palpitation; and in females the catamenial secretion is frequently, but not invariably, defective. That the want of uterine action is not the cause, but in some cases is, perhaps, the effect of this condition of system, seems tolerably clear from the circumstance of the same constitutional symptoms of anæmia: sometimes occurring with a perfect regularity of the uterine functions; moreover, we occasionally meet with anæmia in men. It is sometimes the consequence of haemorrhages—at other times it occurs spontaneously, and without any known cause (Andral, Pathol. Anat. by Townsend and West, i. 97).

If in this condition of system we administer iron, the appetite increases, digestion is promoted, the pulse becomes fuller and stronger, the skin assumes its natural tint, the lips and cheeks become more florid, the temperature of the body is increased, the oedema disappears, and the muscular strength is greatly augmented. The alvine evacuations assume a black colour, as they always do under the use of the ferruginous preparations. After continuing the use of iron for a few weeks, we frequently find excitement of the vascular system (particularly of the brain); thus we have throbbing of the cerebral vessels, and sometimes pain in the head, a febrile condition of system, with a tendency to haemorrhage. Mr. Carmichael (Essay on the Effects of Carbonate of Iron on Cancer, Dubl. 1806, p. 396) considers the sanguine temperament (marked by a high complexion, celerity of thought, remarkable irritability of fibre, and a quick pulse) as depending on an excess of iron in the
Thus, in proper in quantity we must observe this metal promoting the uterine discharge, at another checking it, according as chlorosis or menorrhagia had been previously present; we cannot, therefore, regard the preparations of this metal as having any direct emmenagogue effect, as some have supposed.

Some refer all the other symptoms of anaemia to the abnormal state of the blood, and ascribe the beneficial influence of iron to the improvement in the quality of this liquid. It is certain that, under the use of the preparations of this metal, the blood frequently acquires a more scarlet colour, owing, as it has been fancied, to an increase in the quantity of its colouring particles; and it is said that the crassamentum becomes firmer and more solid, and even increased in quantity. This alteration of the physical and chemical properties of the blood is supposed to render it more stimulating, and thus the different organs, receiving a fluid of a more healthy character, resume their normal condition, and perform their functions in a proper manner. Tiedemann and Gmelin (Vers. üb. d. Wege auf. welch. Subst. aus d. Magen u. Darmk.) have detected it in the serum of the blood of the portal and mesenteric veins of horses and dogs, to whom they administered either the sulphate or chloride; occasionally, too, the urine has been found to contain it. Moreover, Menghini (De ferrurearum particul. progressu ad sanguinem. In Com. Acad. Bonon. t. ii. p. 475) asserts the quantity of iron in the blood of dogs is increased by feeding them on substances mixed with this metal. Furthermore, it is not to be forgotten, that iron exists in no inconsiderable quantity in healthy blood, and is supposed to contribute to its colour, and probably to its stimulant properties; so that it is not unlikely any variation in the quantity of this metal would be attended with an alteration in the action of every organ.

Iron is a substance not readily absorbed, for it remains in the stomach and intestines many days after it is swallowed: in order, therefore, that the ferruginous preparations should have much effect on the general system, it is necessary that they be employed for some considerable time. It does not, like most other metals, act as a poison when it gets into the blood. Another circumstance connected with the operation of iron is likewise deserving of notice; namely, that it has no primary or specific effect on the nervous system, as arsenic, mercury, copper, zinc, bismuth, silver, and many other metals. It must not, however, be imagined from these remarks, that the preparations of iron never operate injuriously. On the contrary, we see them sometimes acting as local irritants on the alimentary canal, as already noticed; and by the use of them in too large quantities, or for too long a period of time, they bring on a hypersthenic or phlogistic diathesis.

Uses. (a.) Of metallic iron.—Iron filings have been used in those cases where the chalybeate preparations generally have been administered, and which will be presently noticed. In some instances, however, the efficacy of iron depends on its being employed in the uncombined state. Thus, when used as an antidote to poisoning by the
salts of copper, it is necessary that the iron be administered in the metallic state, in order to reduce the cuprous salts (vide p. 494). Iron filings have been regarded as anthelmintic, especially in the small thread-worm (the Ascaris vermicularis); they have been used also as an astringent application, to repress faecid secretion of the feet.

(b) Of the ferruginous compounds.—By a careful attention to the known physiological effects of the ferruginous compounds, the indications and contra-indications for their employment may be in great part learned. Thus, the impropriety of administering them where there is irritation or inflammation of the alimentary canal, in plethoric habits, and in persons disposed to inflammatory diseases, or to apoplexy, will be obvious from the foregoing remarks. On the other hand, in all cases characterized by feebleness and inertia of the different organs of the body, by a soft lax condition of the solids, and by a leucophaemic state of the system—where the patient appears to be suffering from a state of general anaemia, already described—the preparations of iron are indicated. It is hardly within the scope of my present object to instance particular diseases where this metal may be used, but rather to point out those conditions of system which affect the employment of iron in diseases generally. I may notice a few cases by way of illustration.

As external or local agents we rarely employ the preparations of iron, since we have other more efficacious and powerful remedies. Occasionally, however, they have been used as astringents, styptics, and caustics. Thus solutions of the sulphate and chloride have been used in the form of injection, in discharges from the urethra and vagina: and the tincture of the chloride is now and then applied as a styptic, or to repress the growth of spongy granulations.

The ferruginous preparations are principally resorted to with the view of affecting the general system. They are frequently given to promote the uterine functions, as in chlorosis, amenorrhœa, dysmenorrhœa, and menorrhagia, and often with success. When chlorosis depends on, or at least is accompanied by, that condition of the system before described under the name of anaemia, the ferruginous preparations are frequently useful; but if it occur in patients of a full habit, or if it arise from inflammation of some organ (as the lungs, stomach, or bowels), chalybeates will do harm. In cases of impotence, connected with or arising from general feebleness, it may be now and then useful; but in nine out of ten cases which we are called on to treat, this condition arises from indulgence in bad habits, which no medicine can affect. Sometimes iron is resorted to in sterility (though Dioscorides says the rust of iron hinders women from conceiving), but the conditions under which it is likely to be useful are precisely those before mentioned for other diseases. In discharges from the genital organs, as gleet and leucorrhœa, the internal employment of the tincture of the chloride of iron, sometimes conjoined with the tincture of cantharides, has been found useful.

In some periodical diseases—namely, ague, asthma, and tic douloureux—the ferruginous preparations have gained considerable repute. In the first of these diseases (that is, ague), the sulphate has been used by Marc (Recherches sur l'Emploi du Sulf. de Fer dans le Traitément des Fièvres Interm. Paris, 1810) and others, the subcarbonate by Buchwald, the ammoniacal chloride by Hartmann; but it has been almost wholly
iron.

superseded, of late years, by the sulphate of quinine and by arsenie. In
asthma, Dr. Bree (On Asthma), who was himself a sufferer from the
disease, regards iron as preferable to all other remedies. However, the
experience of others has not confirmed his favourable opinion of it.
The sesquioxide of iron has latterly been extensively employed, at the
recommendation of Mr. B. Hutchinson (Cases of Tic Doulour. successfully
treated), in tic douloureux, and with variable success; in some cases
acting in a most extraordinarily beneficial manner, in others being of
no avail.

In diseases of the spleen and liver, the ferruginous compounds are
occasionally found useful. I have already alluded to the influence which
they are supposed to possess over these organs; a supposition the more
probable from the occasional remarkable effects produced by them in
diseases of these organs. "I regard iron as a specific," says Cruveilhier,
(Dict. de Méd. et de Chir. Prat. t. viii. p. 62), "in hypertrophy of the
spleen, or chronic splenitis; whether primitive or consecutive to inter-
ditten fevers." After noticing the symptoms attending this con-
dition (such as paleness of the lips, &c. great lassitude, abdominal and
ephalic pulsations, brought on by the slightest exertion; pain at the left
side, disordered state of the digestive organs, accelerated pulse, and
heart easily excited), he goes on to remark, "By the aid of iron I
have obtained the complete resolution of enlargements of the spleen,
which have occupied half, or even two-thirds, of the abdomen." In
hypertrophy of the liver, iron has not been equally serviceable.

Some years ago the preparations of iron were strongly recommended in
cancer by Mr. Carmichael (op. cit.) The grounds on which he was led
to use of them were the probability that cancer had an independent
life—in other words, that it was a kind of parasite, as some preceding
writers, more particularly Dr. Adams, had presumed; and secondly, the
eficacy of iron in destroying intestinal worms, which led him to hope
that it would be equally destructive to other parasites. With these views
employed (externally and internally) various ferruginous compounds—
mainly, the ferroartrate of potash, the subcarbonate (sesquioxide) of iron,
and the phosphates. Whatever hopes may have at one time been enter-
tained of these remedies as curative agents, in this most intractable disease,
they are now completely destroyed. That these medicines are occasionally
useful as palliatives may perhaps be admitted; but they have no cura-
tive powers. Indeed this might have been suspected, from the hypo-
etetical grounds on which they were introduced into use. The proofs of
the parasitical nature of cancer must be much stronger than any yet
offered, ere we can admit this hypothesis. Moreover, the preparations
of iron, though useful, are not so "very effectual" in worms as Mr.
Carmichael's remarks would lead us to imagine.

In certain affections of the digestive organs, the preparations of iron
are occasionally used with benefit; as in some forms of dyspepsia, but
only in the conditions of system already noticed. In some affections
of the nervous system which occur in weak debilitated subjects, it is also
useful; for example, in epilepsy, chorea, hysteria, and the shaking palsy
induced by the vapour of mercury.

These are the most important diseases for which we employ the
ferruginous compounds. There are many other diseases for which chaly-
cretes are occasionally beneficial; but the general principles regulating
their use will be readily comprehended from the foregoing remarks, and I have only to add, in all diseases attended by debility and marked by atony and inertia of organs, more especially in those indicating a disordered state of the haematose functions, the preparations of iron will be found in most instances more or less serviceable. Furthermore, I may enumerate scrofula, rickets, dropsy, and gout, as diseases in which iron has been at times used with advantage.

_Fer'ri Sesquiox'ydum.—Sesquioxide of Iron._

_History._—Gebert (Invent. of Verity, 280) was acquainted with this substance, which he calls _crocus martis_. It was probably known long before his time. It is the red or peroxide of iron of some chemists.

_Natural History._—It is found native in the crystallized state (specular iron or iron glance) and in globular and stalactic masses (red haematite): the finest specimen of the first occur in the Isle of Elba; the second is found near Ulverstone in Lancashire, and in Saxony. The hydrated sesquioxide of iron (brown iron stone) is met with in Scotland and at Shotover Hill, Oxfordshire. Yellow ochre is a hydrated sesquioxide of iron.

_Preparation._—There are several modes of preparing this compound. One method is to calcine crystallized sulphate of iron, by which, first the water and afterwards the sulphuric acid are expelled: the protoxide of iron of the sulphate is peroxidized at the expense of the oxygen of part of the sulphuric acid, and a portion of sulphurous acid gas is developed. The sesquioxide thus procured constitutes the _ferri oxidum rubrum_ of the Dublin and Edinburgh Pharmacopoeias: in commerce it is called colcothar, caput mortuum vitrioli, _trip_, brown-red, or rouge.

Rust of iron (rubigo _ferri_, Ph. Dubl.; _ferri subcarbonas_, Ph. Ed.) is the hydrated sesquioxide sometimes mixed with a little carbonate of the protoxide. It is directed to be prepared by exposing moistened iron (cuttings of wire or filings) to the air, whereby it attracts oxygen both from the air and water. It is then to be reduced to an impalpable powder, by levigation and elutriation. In the shops it is found in little conical masses.

Another mode of preparing sesquioxide of iron is by precipitation. In the London Pharmacopoeia it is directed to be procured by mixing a solution of four pounds of sulphate of iron in three gallons of water, with a solution of four pounds and two ounces of carbonate of soda, also in three gallons of water. The precipitated powder, when washed and dried is a hydrated sesquioxide of iron, mixed with a portion of the protocarbonate. It is the _ferri sesquioxydatum_ of the London Pharmacopoeia, (ferri carbonas, Ph. Dubl.; carbonas _ferri precipitatus_, Ph. Ed.) When procured according to the above directions, its colour is reddish chocolate brown; but the greater part of that met with in the shops has been calcined, and is of a brownish red colour.

The _theory_ of the last mentioned process is as follows:—One equivalent or 76 parts of sulphate of iron are decomposed by one equivalent or 54 parts of carbonate of soda; one equivalent or 58 parts of carbonate of the protoxide of iron precipitate, while one equivalent or 72 parts of sulphate of soda remain in solution.
By exposure to the air during the washing and drying, the carbonate of the protoxide of iron is decomposed, the oxygen of the air combines with the protoxide, and thereby converts it into sesquioxide, while carbonic acid is disengaged. A portion of protocarbonate usually escapes decomposition.

Properties.—The primary form of the crystals of native sesquioxide of iron is the rhombohedron; that of the native hydrated sesquioxide is the cube.

The artificial sesquioxide of the shops is a brownish red powder: when it has been exposed to an intense heat it sometimes has a purplish tint; the hydrated sesquioxide has a chocolate brown tint. It is odourless, insoluble in water, and not magnetic. Prepared according to the London Pharmacopoeia it has a styptic taste; when calcined it is tasteless. When free from carbonate of iron, it dissolves in hydrochloric acid without effervescence.

Characteristics.—Its hydrochloric solution affords a deep blue precipitate with the ferrocyanide of potassium; a purplish black precipitate with tincture of nutgalls; a brownish red precipitate with the alkalies; and a red colour with sulphocyanic or meconic acid.

Composition.—Sesquioxide of iron has the following composition:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent</th>
<th>Gay-Lussac</th>
<th>Berzelius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>1 1/2</td>
<td>28</td>
<td>70</td>
<td>70.27</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1</td>
<td>12</td>
<td>30</td>
<td>29.73</td>
</tr>
<tr>
<td>Sesquioxide of Iron</td>
<td>1</td>
<td>40</td>
<td>100</td>
<td>100.00</td>
</tr>
</tbody>
</table>

When prepared by precipitation, it usually contains some carbonate of the protoxide; and, when digested in hydrochloric acid, some carbonic acid evolves. According to Mr. Phillips, the quantity of carbonate in the preparation of the shops is only 4 per cent.

Purity.—Adulteration is hardly to be apprehended. If it should contain copper, its hydrochloric solution will deposit this metal on a bright rod of iron. After the sesquioxide has been thrown down by ammonia from the hydrochloric solution, the supernatant liquor should give no indications of containing any other metal in solution; and chloride of barium ought not to occasion any precipitate.

Physiological Effects.—It is termed alterative, tonic, and emmenagogue. Its obvious effects on the body are very slight. It produces blackness of the stools; and in large doses occasional nausea, a sensation of weight at the pit of the stomach, and sometimes dyspeptic symptoms. It possesses little or no astringency. The constitutional effects, arising from the continued use of it, are those produced by the ferruginous compounds generally, and which have been before described (p. 534).

Uses.—It may be employed in any of the before mentioned cases (p. 536) in which the ferruginous tonics are indicated. It has been strongly recommended by Mr. Benjamin Hutchinson (Cases of Tic Douloureux successfully treated, 1820) as a remedy for
neuralgia, and in some cases it gives complete, in others partial, relief. But in many instances no benefit whatever is obtained from its use, and in one case in which I prescribed it, the patient fancied it increased her sufferings.

Mr. Carmichael, as I have before mentioned (p. 537), has recommended it as a remedy for cancerous diseases.

The use of the hydrated sesquioxide of iron, as an antidote for arsenious acid, has been before noticed (p. 396).

**Administration.**—The usual dose of this preparation, as a tonic and emmenagogue, is from ten grains to half a drachm, combined with astringents, to enable it to sit more easily on the stomach. In tic douloureux it is given in much larger doses, as from half a drachm to two, three, or four drachms.

**Emplastrum Oxidi Ferri Rubri**, Ph. Ed.; *Emplastrum Thuris*, Ph. Dub. (Litharge plaster, tij.; frankincense [concrete juice of Pinus Abies] tbss.; red oxide of iron, sij. M. Ph. Dub. In the Edinburgh Pharmacopoeia, resin, wax, and oil, are substituted for the frankincense, and the quantity of oxide is nearly three times as much).—This is the old *emplastrum roborans* or strengthening plaster, and is employed, spread on a leather, as a mechanical support and slight stimulant, in muscular relaxation, lumbago, weakness of the joints, &c.

**Ferri Ox'y'dum Ni'grum.—Black Ox'ide of Iron.**

**History.**—It was first employed as a medicine by Lemery in 1735. It is the *martial Ethiops*(Æthiops martialis) of some writers, and the *oxy'dum fer'ro-so'ferricum* of Berzelius. It is sometimes termed the *magnetic oxide*.

**Natural History.**—It occurs in the mineral kingdom under the name of magnetic iron ore, the massive form of which is called native lodestone. It is found in Cornwall, Devonshire, Sweden, &c.

**Preparation.**—In the Dublin Pharmacopoeia it is directed to be procured by washing and drying the scales of the oxide of iron (*ferri oxy'di squamae*), and then separating them from impurities by means of a magnet. They are afterwards to be reduced to a very fine powder by levigation and elutriation.

Other modes of preparing this compound are described in chemical works. The above is a cheap method, and yields a product sufficiently pure for the purposes of medicine. The process of the Paris Codex is regarded as a superior one. It consists in covering filings of iron with water, and exposing the mixture to the air; then, by elutriation, separating the black powder.

**Properties.**—It is a velvet-black powder, soluble in hydrochloric acid without effervescence, and magnetic.

**Characteristics.**—Its hydrochloric solution affords a green or greenish-brown precipitate with a caustic alkali, and a greenish or blue precipitate with ferrocyanide of potassium. Its other characteristics are the same as those of the ferruginous compounds generally.

**Composition.**—It is a mixture or compound of protoxide and sesquioxide of iron. According to Mosander (Turner's *Elements of Chemistry*), scales of iron have the following composition:
Tincture of Sesquichloride of Iron.

<table>
<thead>
<tr>
<th>Outer layer.</th>
<th>Inner layer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eq.</td>
<td>Eq. Wt.</td>
</tr>
<tr>
<td>Protoxide of Iron</td>
<td>2</td>
</tr>
<tr>
<td>Sesquioxide of Iron</td>
<td>1</td>
</tr>
<tr>
<td>Scales of Iron</td>
<td>1</td>
</tr>
</tbody>
</table>

Purity.—It should be readily soluble in hydrochloric acid, without effervescence, by which the absence of metallic iron is shown.

Physiological Effects.—Its general effects are the same as the purgative compounds already described (p. 534). It is a more valuable preparation than the sesquioxide, in consequence of being more readily soluble in the fluids of the stomach. When it contains metallic iron it causes eructations of hydrogen gas.

Uses.—It is employed in the same cases as other chalybeates (vide p. 536).

Administration.—The dose of it is from five grains to a scruple twice or thrice daily.

Tinctura Fer'ri Sesquichlo'ridi.—Tincture of Sesquichloride of Iron.

History.—This compound has been long in use, and is commonly termed the tincture of the muriate of iron. It is the liquor of muriate of iron (muriatis ferri liquor) of the Dublin Pharmacopoeia.

Preparation.—In the London Pharmacopoeia it is prepared by pouring a pint of hydrochloric acid upon six ounces of sesquioxide of iron in a glass vessel, and digesting for three days, frequently shaking; then adding three pints of rectified spirit, and straining. In the Dublin Pharmacopoeia, one part of rust of iron, six parts of hydrochloric acid, and six parts of rectified spirit, are used; the hydrochloric solution is evaporated to one-third before the spirit is added, by which the excess of hydrochloric acid is driven off. In the Edinburgh Pharmacopoeia, three ounces of the black oxide of iron, ten ounces (or as much as may be sufficient) of hydrochloric acid, and sufficient alcohol to make the whole amount two pounds and a half: this solution is more apt to decompose, owing to the presence of a larger quantity of protochloride, and the subsequent formation of sesquioxide.

By digestion in hydrochloric acid the sesquioxide becomes the sesquichloride of iron, and some water is formed.

Reagents.

<table>
<thead>
<tr>
<th>eq. Hydrochloric Acid</th>
<th>111</th>
<th>3 eq. Hydrogen</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>eq. Sesquioxide of Iron</td>
<td>80</td>
<td>3 eq. Chlorine</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 eq. Oxygen</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 eq. Iron</td>
<td>56</td>
</tr>
</tbody>
</table>

Results.

As the sesquioxide of iron employed in the London and Dublin Pharmacopoeias contains a small portion of proto carbonate of iron, a little protochloride of iron is formed, and slight effervescence, owing to the escape of carbonic acid, takes place. Both the chlorides of iron are soluble in water as well as in spirit.

Properties.—This tincture is of a reddish brown colour, and stains white paper yellow. It has a sour styptic taste, and an odour of hydrochloric ether, so that it would appear that a mutual reaction takes place between the hydrochloric acid and the alcohol. It reacts on vegetable colours as an acid. "Its sp. gr. is about 0.992, and a fluidounce yields,
when decomposed by potash, nearly 30 grains of sesquioxide of iron," (Mr. R. Phillips, *Transl. of the Lond. Pharm.*)

**Characteristics.**—Its reaction on vegetable colours, its inflammability, its remarkable odour, its affording chloride of silver when treated by nitrate of silver, and its reaction, like the other ferruginous compounds (p. 533), are properties sufficient to characterize it. It forms a brown semitransparent jelly with mucilage of gum arabic.

**Composition.**—This tincture consists of *rectified spirit*, a small portion of *hydrochloric ether*, *hydrochloric acid*, sesquichloride of iron, and a little *proto-chloride of iron*. Unless excess of hydrochloric acid be present, sesquioxidc of iron is thrown down when the tincture is exposed to the air, owing to the iron of the chloride attracting oxygen, and becoming sesquioxide.

Sesquichloride of iron has the following composition:

<table>
<thead>
<tr>
<th>Eq.Wt</th>
<th>Eq.</th>
<th>Per Cent.</th>
<th>J. Davy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>iron</td>
<td>1</td>
<td>28</td>
<td>34·15</td>
</tr>
<tr>
<td>chlorine</td>
<td>1½</td>
<td>54</td>
<td>65·85</td>
</tr>
<tr>
<td>sesquichloride of iron</td>
<td>1</td>
<td>92</td>
<td>100·00</td>
</tr>
</tbody>
</table>

**Purity and Strength.**—The commercial tincture of sesquichloride of iron varies in its strength, owing to the varying strength of the hydrochloric acid employed. Moreover, a diluted spirit is frequently substituted for rectified spirit. These differences can only be discovered by examining the colour and specific gravity of the tincture, as well as the quantity of oxide which it yields.

**Physiological Effects.**—This is, in its local action, one of the most powerful of the preparations of iron. It acts as an energetic astringent and styptic, and in large doses as an irritant. The large quantity of free hydrochloric acid which the tincture of the shops frequently contains, contributes to increase its irritant properties; and in Dr. Christie's *Treatise on Poisons* is a brief notice of a case in which an ounce and a half of this tincture was swallowed, and death occurred in about six weeks—the symptoms during life, and the appearances after death, being those indicative of inflammation of the alimentary canal. When swallowed in large medicinal doses it readily disorders the stomach. The general or constitutional effects of this preparation agree with those of other ferruginous compounds. It appears to possess, in addition, powerfully diuretic properties. Indeed it would seem to exercise some specific influence over the whole of the urinary apparatus; for on no other supposition can we explain the remarkable effects which it sometimes produces in affections of the kidneys, bladder, urethra, and even of the prostate gland. It colours the faces black; and usually constipates the bowels.

**Uses.**—It is sometimes, though not frequently, used as a topical agent. Thus it is applied as a *caustic* to venereal warts, and to spongy granulations. As an *astringent* it is sometimes employed as a local application to ulcers attended with a copious discharge; or as a *styptic* to stop haemorrhage from numerous small vessels.

Internally it may be employed as a *tonic* in any of the cases in which the other ferruginous compounds are administered, and which I have already mentioned. It has been especially commended in scrofula.

In various affections of the urino-genital organs it is frequently used.
with great success. Thus, in retention of urine, arising from spasmodic stricture, its effects are sometimes beneficial. It should be given in doses of ten minims every ten minutes until benefit is obtained, which frequently does not take place until nausea is excited. It has been used with success by Mr. Cline (Med. Records and Researches, Lond. 1798); by Mr. Collins (Med. and Phys. Journ. xvi. 250); by Drs. Thomas, Eberle, and Francis (Eberle's Treat. on Mat. Med. ii. 270, 2d ed.); and by Dr. Davy (Paris's Pharmacologia, ii. 478, 6th ed.). However, Mr. Lawrence (Lond. Med. Gaz. vi. 845), alluding to Mr. Cline's recommendation of it, observes, "I believe general experience has not led others to place any very great confidence in the use of this remedy." In gleet and leucorrhœa it is sometimes serviceable. I have found it occasionally successful, when given in conjunction with the tincture of cantharides, in the latter stage of gonorrhœa, after a variety of other remedies had failed. In passive haemorrhage from the kidneys, uterus, and bladder, it is likewise employed with benefit.

Administration.—The dose of it is from ten to thirty minims gradually increased to one or two drachms, and taken in some mild diluent.

Antidotes.—In a case of poisoning by it the treatment should be the same as for the mineral acids (vide pp. 154 and 208.)

Fer'ri Ammonio-Chl'oridum.—Ammonio-Chloride of Iron.

History.—This compound, which was known to Basil Valentine, has had various appellations, such as flores salis ammoniaci martiales, ferrum ammoniacale, or ferrum ammoniatum.

Preparation.—In the London Pharmacopœia it is directed to be prepared by digesting three ounces of sesquioxide of iron with half a pint of hydrochloric acid in a sandbath for two hours; afterwards adding two pounds and a half of hydrochlorate of ammonia dissolved in three pints of distilled water. The liquor is to be strained and evaporated, and the residue rubbed to powder.

By the mutual reaction of sesquioxide of iron and hydrochloric acid we obtain sesquichloride of iron and water, as explained at p. 541. A small portion of protochloride of iron must also be produced by the action of hydrochloric acid on the carbonate of the protoxide of iron usually contained in the sesquioxide of the Pharmacopœia. By evaporating the solution of the two chlorides with a solution of hydrochlorate of ammonia, we obtain a mixture of these bodies. There is no reason to believe that any chemical combination takes place.

Properties.—It is met with in the shops in the form of reddish orange-coloured crystalline grains, having a feeble odour and a styptic saline taste. It is deliquescent, and is soluble in both water and alcohol.

Characters.—Rubbed with quicklime or caustic potash, ammonia is evolved. Its solution affords chloride of silver when mixed with the muriate of silver. It reacts as a ferruginous salt (p. 533).

Composition.—It is a mechanical mixture of hydrochlorate of ammonia and sesquichloride of iron, in the following proportions:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesquichloride of Iron</td>
<td>. . . . . .</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Hydrochlorate of Ammonia</td>
<td>. . . . . .</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Ferri Ammonio-Chloridum</td>
<td>. . . . . .</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
It yields about 7 per cent. of sesquioxide of iron when decomposed by an alkali (Phillips):

The yellow bands sometimes found in cakes of hydrochlorate of ammonia are probably a true chemical compound of sesquichloride of iron and hydrochlorate of ammonia (vide p 180; also Mr. Jackson, Lond. Med. Gaz. Aug. 4, 1837).

Physiological Effects.—It produces the general effects of the ferruginous preparations; but, on account of the small and variable quantity of iron present, it is a compound which is of little value. The hydrochlorate of ammonia, which it contains, renders it alterative, and in large doses aperient.

Uses.—It has been employed as a deobstruent in glandular swellings, in amenorrhœa, and other cases where the preparations of iron are usually employed.

Administration.—It may be given in substance in doses of from four to twelve grains.

Tinctura Ferri Ammonio-Chloridi, Ph. Lond. (Ammonio-chloride of iron, 5iv.; proof spirit, Oj. M.)—"A fluidounce yields by decomposition 5·8 grains of sesquioxide of iron," (Phillips, op. cit.) It should be expunged from the Pharmacopœia.

Fer'ri I'o'didum.—I'odide of I'ron.

History.—We are indebted to Dr. A. T. Thomson for the introduction of this substance into medicine (Observat. on the Preparation and Medicinal Employment of Ioduret and Hydriodate of Iron, 1834).

Preparation.—In the London Pharmacopœia it is directed to be prepared as follows:—Mix six ounces of iodine with four pints of water, and to these add two ounces of iron filings. Heat them in a sand-bath and when it has acquired a greenish colour, pour off the liquor. Wash the residue with half a pint of boiling water. Evaporate the mixed and strained liquors at a heat not exceeding 212° in an iron vessel, that the salt may be dried. Keep it in a well-stoppered vessel, the access of light being prevented. In this process one equivalent or 126 parts of iodine combine with one equivalent or 28 parts of iron to form one equivalent or 154 parts of iodide of iron. Dr. Thomson has "found the soft iron wire used for stringing pianofortes preferable to the filings."

Properties.—It is an opaque iron grey crystalline mass, with a faint metallic lustre and a styptic taste. It may be obtained in acicular crystals. It is fusible, volatile, very deliquescent, and very soluble in both water and alcohol. It readily attracts oxygen from the air, and forms sesquioxide and sesquiodide of iron.

Characteristics.—By the application of heat the violet vapour of iodine is evolved, and sesquioxide of iron is left. If this be dissolved in an acid (hydrochloric, nitric, or sulphuric), the liquid reacts as a solution of a ferruginous salt (vide p. 533). Thus, ferrocyanide of potassium strikes a blue, tincture of galls a bluish black, meconic or sulphocyanic acid a red, colour. Furthermore, the alkalies throw down from it the reddish brown sesquioxide of iron.

Composition.—The composition of crystallized iodide of iron, according to Mr. Phillips (Transl. of the Pharm.), is as follows:
Purity.—It should be perfectly soluble in water. By exposure to the air it forms sesquioxide and sesquiodide of iron: the latter is soluble, the former is insoluble, in water. To preserve a solution of this salt, a coil of soft iron wire is to be kept immersed in it: this prevents the formation of sesquiodide of iron, though it does not that of sesquioxide.

Physiological Effects. (a.) On animals.—Three drachms of iodide of iron were administered to a dog: vomiting and purging were produced, but in three days the animal was well. One drachm dissolved in a drachm of water killed a rabbit in three hours and a half, with the appearance of gradually-increasing debility: the stomach was found congested, and its lining membrane decomposed. Forty grains injected into the jugular vein of a dog killed the animal within twelve hours: the symptoms were dilatation of the pupils, staggering, vomiting, and bloody tools, (Cogswell, Essay on Iodine and its Compounds, p. 128, et seq.)

(b.) On man.—In small and repeated doses its effects are not very obvious, save that of blackening the stools. It passes out of the system in the urine, and both of its constituents may be detected in this fluid. When it does not purge, it frequently acts as a diuretic. In full doses, as ten grains, it on one occasion caused uneasy sensation at the epigastrium, nausea, slight headache, copious black stool, and, in two hours, a larger quantity of urine, containing both iron and iodine (Dr. A. T. Thomson, *p. cit.*). Its medicinal influence on the body seems to be stimulant, tonic, and alterative or obdoutrous. Dr. Thomson regards it as possessing the combined properties of iron and iodine.

Uses.—In scrofulous affections the united influence of iodine and iron sometimes beneficial. In chlorosis, and in atonic amenorrhoea, Dr. Thomson found it serviceable; and his testimony of its good effects has been supported by that of others. Its operation must be promoted by exercise and an invigorating diet. In a case of anaemia, without any disturbance of the uterine function, I found it useless; while the compound iron mixture was of essential service. In secondary syphilis occurring in debilitated and scrofulous subjects, it is in some cases, according to the testimony of both Dr. Thomson and Ricord (Journ. de Pharm. xxiii. 303), a valuable remedy. The last-mentioned writer employed it in the form of injection (composed of from a half drachm to a drachm of iodide dissolved in eight ounces of water) in blennorrhoeas, and a that of lotion in venereal and carious ulcers. Dr. Pierquin (quoted by Dierbach, Neueste Entw. in d. Mat. Med. 2te Ausg.) employed it internally and externally in leucorrhoea and amenorrhoea. It has also been used in incipient cancer and in atonic dyspepsia (Thomson).

Administration.—The dose of it is three grains gradually increased to eight or ten. Ricord has given forty grains per day. It may be exhibited in the form of tincture or of aqueous solution, flavoured with a little tincture of orange-peel. It must be remembered that acids, alkali, and their carbonates, most metallic salts, all vegetable astringents, and any organic solutions, decompose it. Pierquin gave it in chocolate,
Bourdeau wine, distilled water, diluted spirit, or made into lozenges with saffron and sugar. In leucorrhœa and amenorrhœa he employed an ointment (composed of a drachm of iodide to an ounce of lard), by way of friction in the upper part of the thighs.

Fer'ri Fer'ro-sesquicyan'idum.—Fer'ro-sesquicyanide of I'ron.

History.—This compound was accidentally discovered at the commencement of the last century by Diesbach and Dippel. It was termed Prussian or Berlin blue (cœruleum Borussicum seu Berolinense). In the London Pharmacopœia it is called percyanine of iron (ferri percyani-dum); in the Dublin Pharmacopœia, cyanuret of iron (ferri cyanuretum); in the United States Pharmacopœia, ferrocyanate of iron (ferri ferrocyanas). It is sometimes termed ferropressivate of iron.

Preparation.—It may be prepared by mixing a solution of persulphate or perchloride of iron with a solution of ferrocyanide of potassium.

In commerce it is procured by adding a mixture of two parts of alum and one of sulphate of iron to an impure solution of ferrocyanide of potassium (called lixivium sanguinis). A dingy-green precipitate falls, which, by repeated washing with very dilute hydrochloric acid, and exposure to the air, becomes gradually of a deep blue. It is then collected and drained in a cloth, and afterwards dried. By the reaction of ferrocyanide of potassium on sulphate of the protoxide of iron, sulphate of potash is formed in solution, and a white precipitate (cyanide of iron) subsides, which, by exposure to the air, becomes blue (ferrosesquicyanide of iron), in consequence of part of its iron combining with oxygen to form sesquioxide of iron. Ferrocyanide of potassium, with sulphate of the sesquioxide of iron, forms sulphate of potash and ferrosesquicyanide of iron. The green colour of the precipitate above alluded to depends on the presence of sesquioxide (thrown down by the carbonate of potash of the lixivium sanguinis), which is removed by hydrochloric acid. Commercial Prussian blue contains alumina (derived from the alum), and usually some sesquioxide of iron.

The following diagram illustrates the reaction of ferrocyanide of potassium on sulphate of the sesquioxide of iron:

<table>
<thead>
<tr>
<th>REAGENTS.</th>
<th>RESULTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 eq. Sesquisulph. Iron...... 400</td>
<td>6 eq. Sulphate of Potash...... 325</td>
</tr>
<tr>
<td>3 eq. Ferrocyanide</td>
<td>6 eq. Cyanide Potassium 368</td>
</tr>
<tr>
<td>6 eq. Cyanide Potas...... 306</td>
<td>6 eq. Cyan. 156 6 eq. Potas 240</td>
</tr>
<tr>
<td>6 eq. Oxyg. 48</td>
<td>4 eq. Sesquicyriron 205</td>
</tr>
<tr>
<td>6 eq. Sulphuric Acid...... 210</td>
<td>1 eq. Ferrosesquicyanise Iron 430</td>
</tr>
<tr>
<td>6 eq. Oxyg. 48</td>
<td>6 eq. Potas 288</td>
</tr>
<tr>
<td>14 eq. Iron...... 112</td>
<td></td>
</tr>
</tbody>
</table>

Properties.—Prussian blue occurs in masses of a rich dark blue colour. It is tasteless and inodorous. When broken it has a copper or bronze tint, somewhat like that of indigo, but which is distinguished from that of the latter by its being removed by rubbing with the nail. It is insoluble in water, alcohol, and the diluted mineral acids. Strong sulphuric acid forms with it a white pasty mass, from which water again separates Prussian blue. Both nitric acid and chlorine decompose it. Hydrochloric acid abstracts part of its iron.

Characteristics.—Its colour and copper tint above described form part of its characteristics. Boiled with water and binoxide of mercury
yields bieyanide of mercury (vide p. 487). Boiled with solution of
potash it forms ferrocyanide of potassium (vide p. 547). Heated in a
tort it yields water, hydrocyanate of ammonia, then carbonate of
ammonia, and leaves a black, carbonaceous, and ferruginous mass.

Composition.—The following is the composition of pure and an-
drous Prussian blue:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>196</td>
<td>43:5</td>
</tr>
<tr>
<td>Cyanogen</td>
<td>234</td>
<td>54:3</td>
</tr>
</tbody>
</table>

Ferrocyanide of iron 1 .. 430 .. 100:0

Purity.—Prussian blue of commerce usually contains alumina and
squoioxide of iron. These may be detected by boiling the suspected
compound with diluted hydrochloric acid, which dissolves both the
impurities. Caustic ammonia added to the filtered solution will throw
own the impurities; excess of the alkali will redissolve the alumina.

Physiological Effects. (a.) On animals.—Coullon gave it to dogs
and sparrows without killing them; and Schubarth states that the only
effect produced on a dog by two drachms was dejection (Wibmer, Wirk.
Arzneim, ii. 356).

(b.) On man.—Its effects on man are not very obvious. It is reputed
mercurial, tonic, and febrifuge. Sachs (Handwort d. prakt. Arzneim, ii.
77) calls it a resolvent tonic.

Uses.—It has been recommended by Dr. Zollickofer (Treatise on
the Use of Prussian Blue in Intermittent and Remitting Fevers, Mary-
land, 1822) as a more certain, prompt, and efficacious remedy for inter-
mitting and remitting fevers than cinchona; and particularly adapted for
children, on account of its insipidity and smallness of dose. It may be
administered during the paroxysm as well as in the intermission, and
es not disagree with the most irritable stomach. Hosack (New
York Medical and Physiological Journal, 1823, quoted by Richter, Ausf.
Arzneim), Eberle (Mat. Med. i. 238), and others, have borne testimony to
its good effects. Subsequently, Zollickofer found it useful in dysentery.
alkhoff (Froriep's Notizen, Bd. xvii. 340) used it for many years in
leprosy, with the best results, having cured some cases of several years' 
standing. It has also been employed by Dr. Bridges, of Philadelphia,
United States Dispens.) in a case of severe and protracted facial neuralgia,
with very considerable relief. Lastly, it has been used in the form of
ointments, as an application to foul ulcers.

In pharmacy it is employed in the manufacture of bieyanide of mercury.

Administration.—The dose of commercial Prussian blue is from four
six or more grains every four hours. The ointment above referred to
may be prepared with a drachm of Prussian blue and an ounce of lard.

Potassium Fer'ro-cyan'ide.—Fer'ro-cyan'ide of Potas'sium.

History.—This salt was accidentally discovered at the commence-
ment of the last century. It has had a variety of appellations, such as
assiate of potash, ferro-prussiate of potash, and ferrocyanate of potash.

Preparation.—The usual method of obtaining it is the follow-
ing:—“Into an egg-shaped iron pot, brought to moderate ignition, project
a mixture of good pearl-ash and dry animal matters, of which hoofs and
feathers are the best, in the proportion of two parts of the former to five of
the latter. Stir them well with a flat iron paddle. The mixture, as it calcines, will gradually assume a pasty form, during which transition it must be tossed about with much manual labour and dexterity. When the conversion into a chemical compound is seen to be completed by the cessation of the foetid animal vapours, remove the pasty mass with an iron ladle. If this be thrown, while hot, into water, some of the prussic acid will be converted into ammonia, and of course the usual product diminished. Allow it to cool, dissolve it in water, clarify the solution by filtration or subsidence, evaporate, and on cooling, yellow crystals of the ferroprussiate of potash will form. Separate these, re-dissolve them in hot water, and by allowing the solution to cool very slowly, larger and very regular crystals may be had,” (Ure’s Dictionary of Chemistry.)

Properties.—This salt crystallizes in large, beautiful, lemon-yellow, transparent, permanent, inodorous crystals, whose primary form is an octahedron with a square base. They have a peculiar toughness or flexibility somewhat analogous to selenite. Their sp. gr. is 1.832. They have a sweetish, yet somewhat bitter, saline taste. They are insoluble in alcohol, but dissolve readily in both hot and cold water. When moderately heated they evolve about 13 per cent. of water of crystallization, and are converted into a white friable powder (anhydrous ferrocyanide of potassium.) When heated to redness in contact with air, the cyanide of iron of the salt is decomposed and the residuum consists of cyanide of potassium, oxide of iron, and carbon: by a more continued heat hydrocyanic acid and ammonia are evolved, while the residue consists of sesqui-oxide of iron and carbonate of potash.

Characteristics.—A solution of this salt throws down, with the protosalts of iron, a white precipitate, which by exposure to the air becomes blue. With the persalts of iron it forms a deep blue; with the salts of copper a deep brown; and with those of lead a white precipitate: the precipitates are ferrocyanides of the respective metals. Heated with dilute sulphuric acid, hydrocyanic acid is evolved, and a white precipitate formed, which, by exposure to the air, becomes blue (vide p. 236.) Hydrosulphuric acid, the sulphurets, alkalies, or tincture of galls, give no precipitate with a solution of this salt; shewing that the iron which it contains is in some remarkable state of combination. If a solution of the ferrocyanide of potassium be boiled with binoxide of mercury, bicyanide of mercury is formed in solution, and sesqui-oxide of iron precipitated. The presence of potassium is best shown by calcining the salt, and detecting potash by the usual tests in the residuum. If chlorine be passed through a solution of ferrocyanide of potassium, it abstracts one equivalent of potassium from every two equivalents of the ferrocyanide, by which one equivalent of the ferrosesquicyanide of potassium is formed in solution, and by evaporation this salt may be obtained in the form of red crystals, which throw down a blue precipitate with the protosalts of iron, but occasion no change with the persalts of iron.

Composition.—Crystallized ferrocyanide of potassium has the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanide of Iron</td>
<td>1</td>
<td>54</td>
<td>29.35</td>
</tr>
<tr>
<td>Cyanide of Potassium</td>
<td>2</td>
<td>132</td>
<td>61.97</td>
</tr>
<tr>
<td>Water</td>
<td>3</td>
<td>27</td>
<td>12.67</td>
</tr>
<tr>
<td>Crystl. Ferrocyanide Potassium</td>
<td>1</td>
<td>213</td>
<td>99.99</td>
</tr>
</tbody>
</table>

548 ELEMENTS OF MATERIA MEDICA.
Physiological Effects. (a.) On animals. — Schubarth (Wibmer, "Färk. d. Arzneim." gave two drachms to one dog, and half an ounce to another, without observing any injurious consequences. Callies Wibmer, *op. cit.*, also Christison's *Treat. on Poisons*) found the commercial ferrocyanide of potassium slightly poisonous, but when prepared with care he remarked that several ounces might be given with impunity. These and other experiments show that this salt possesses very little activity. The rapidity with which it is absorbed and gets into the circulation, as the urine, is most remarkable. Westrum (Müller's *Phyto-
ology*, by Baly, i. 247) recognised it in the urine, in from two to ten minutes after it was taken into the stomach. Hering (Lond. Med. Gaz. i. 250) has shown the amazing rapidity with which it traverses the body when it once gets into the blood. Thus, when it was placed in one regular vein of a horse, he recognised it in the opposite one in from twenty to thirty seconds.

(b.) On man.—It has no great influence on man. D'Arcet swallowed half a pound of a solution of this salt, prepared as a test, without any ill effects (Merat and De Lens, *Dict. Mat. Méd.* ii. 532). "Similar results," observes Dr. Christison (*Treatise*, p. 699), "were obtained previously with smaller doses by Wollaston, Marquet, Emmert, as well as afterwards by Dr. Macenven and Schubarth, who found that a drachm or even two drachms might be taken with impunity by man and the lower animals."

Dr. Smart (*Amer. Journ. of Med. Sciences*, xv. 362), however, regards it as possessed of some activity. He asserts that its primary action is that of a sedative, softening and diminishing the fulness and frequency of the pulse, and allaying pain and irritation. In a healthy person, he says, a full dose will often reduce the number of pulsations ten beats in a minute, in a few minutes after being taken; and in a diseased state of the system, accompanied with increased arterial action, the sedative effects are much more striking. Occasionally also it acts as a diaphoretic (in cases accompanied with excessive vascular action and increased heat of skin) and astringent, as seen in its power of diminishing excessive discharges. In some cases, he says, it caused ptyalism, with redness, swelling, and tenderness of the gums, but unaccompanied with swelling of the salivary glands or faètor. An over-dose, he tells us, occasions vertigo, coldness, and numbness, with a sense of gastric sinking; sometimes universal tremors, as in an ague fit. Further evidence, however, is required to confirm these statements, which do not accord with the observations before reported.

Uses. — Hitherto it has rarely been employed in medicine. Dr. Smart employed it as a sedative in diseases of increased action of the vascular system and morbid sensibility of the nerves, as in crysipelas, to allay pain, in cephalalgia, in inflammation of the brain, in chronic bronchitis, &c. In the last-mentioned disease it lessened the frequency of pulse, the sweating, the cough, and the dyspnoea. As an anodyne, he gave it in neuralgia. In hooping-cough he speaks highly of it. As an astringent, he administered it to check colliquative sweating in chronic bronchitis and phthisis, to diminish leucorrhœal discharge and to allay diarrhoea. Rau (Dierbach, *Neueste Entd. in d. Mat. Med.* i. 371, 1837) employed it in calculous complaints.

Administration.—The dose, according to Dr. Smart, is from ten to
fifteen grains, given in the form of solution every four or six hours, Ran gave as much as forty grains at a dose, and I have no doubt that very much larger doses may be given with safety.

Fer'ri Sul'phas.—Sul'phate of I'ron.

History.—Sulphate of iron is one of the substances which Pliny (Hist. Nat. xxxiv. 32) termed chalcanthum. This is evident from the circumstance of his statement that the Romans called it atramentum sutorium, or shoe-maker's black. It is frequently termed copperas, and in consequence has been sometimes confounded with the salts of copper (Dr. Cummin, Lond. Med. Gaz. xix. 40): green vitriol (vitriolum viride), vitriol of Mars (vitriolum martis), salt of Mars (sal martis), vitriolated iron (ferrum vitriolatum), are other names by which it has been known.

Natural History.—It is found dissolved in some mineral waters (sulphated chalybeate, vide p. 145), as those of the Hartfell Spa, Scotland. In the aluminous chalybeate waters it is associated with sulphate of alumina; as in the water of Sand Rock, Isle of Wight. The strong Moffatt chalybeate, and Vicar's Brig chalybeate, contain the sulphate of the sesquioxide of iron. Sulphate of iron is also found in the waters of several copper mines.

Sulphate of the protoxide of iron is rarely met native in the crystallized state. It occurs, however, in Rammelsberg mine, near Goslar; at Schwartzenburg, in Saxony; at Hurlet, near Paisley; and in New England (Phillips's Mineralogy, by Allan).

Dr. Thomson (Mineralogy) has described two native sulphates of the sesquioxide of iron, and an aluminous protosulphate.

Preparation.—Sulphate of the protoxide of iron is prepared by dissolving clean unoxidized iron in diluted sulphuric acid. The proportions employed in the London Pharmacopœia are eight ounces of iron filings, fourteen ounces of sulphuric acid, and four pints of water. The Dublin Pharmacopœia employs two pints more water.

In this process an equivalent or 28 parts of iron decompose one equivalent or 9 parts of water, combine with an equivalent or 8 parts of oxygen, and set free an equivalent or 1 part of hydrogen, which escapes in the gaseous form. The equivalent or 36 parts of protoxide iron, thus formed, combines with an equivalent or 40 parts of sulphuric acid, to form an equivalent or 76 parts of sulphate of iron.

<table>
<thead>
<tr>
<th>REAGENTS</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 eq. Water</td>
<td>9 eq. Hydrogen 1</td>
</tr>
<tr>
<td>1 eq. Iron</td>
<td>1 eq. Oxygen</td>
</tr>
<tr>
<td>1 eq. Sulphuric Acid</td>
<td>0</td>
</tr>
</tbody>
</table>

The common green vitriol, or copperas of the shops, is prepared by exposing heaps of moistened iron pyrites (bisulphuret of iron) to the air for several months. In some places the ore is previously roasted. The moistening is effected by rain or by manual labour. The pyrites attracts oxygen, and is converted into a supersulphate of iron, which is dissolved out by lixiviation; and to the solution thus obtained old iron is added to saturate the free acid. It is then concentrated in leaden boilers, and run off into large vessels (lined with lead) to crystallize.

Properties.—Sulphate of the protoxide of iron crystallizes in
transparent pale bluish green crystals, the primary form of which is the
acute rhombic prism. Their sp. gr. is 1.82. They have an acid, styptic

taste, and reddish litmus. By exposure to the air oxygen is absorbed,
and they acquire, first, a yellowish and darker green tint (sulphate of the
nickel oxide), then slightly effloresce, and become covered with a yellow
rust, which subsequently becomes a brownish (sulphate of the sesquis-
oxide of iron). When heated the crystals undergo the watery fusion,
become white and pulvcrent: at an intense heat they become
deprived of their acid. They are soluble in water, but insoluble in
alcohol. They require two parts of cold, and three-fourths of their
weight of boiling water, to dissolve them. The solution has a bluish
green colour, but by exposure to the air it attracts oxygen, becomes
reddish yellow, and deposits a tetrarsulphate of the sesquisoxide of iron.

CHARACTERISTICS.—It is known to be a sulphate by chloride of barium
(vide p. 265). Binoxide of nitrogen communicates a deep olive colour
in a solution of this salt (vide p. 160). Ferrocyanide of potassium causes
white precipitate, which, by exposure to the air, becomes blue with a
solution of the sulphate of the protoxide: if any sesquisoxide be present,
bluish precipitate is obtained. Alkalis throw down the greenish white
hydrated protoxide of iron (vide p. 333).

COMPOSITION.—The composition of this salt is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Berzelius.</th>
<th>Thomson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphate of Iron</td>
<td>1</td>
<td>36</td>
<td>25.9</td>
<td>25.7</td>
<td>26.7</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>1</td>
<td>40</td>
<td>28.8</td>
<td>28.9</td>
<td>28.3</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
<td>63</td>
<td>45.3</td>
<td>45.4</td>
<td>45.0</td>
</tr>
</tbody>
</table>

crystallized Sulphate of the
Protoxide of Iron . 1 139 100.0 100.0 100.0

PURITY.—This salt is frequently mixed with sulphate of the sesquis-
oxide: this may be known by the yellowish green colour of the crystals,
and by the blue colour produced on the addition of ferrocyanide of
potassium.

The common green vitriol, or copperas of the shops, is a mixture of the
sulphates of the protoxide and sesquisoxide of iron. It sometimes con-
ains copper, which may be recognized by immersing a clean iron spatula
in a solution of it; the iron becomes incrusted with copper: or it may be
detected by adding excess of caustic ammonia, and filtering the liquor.
If copper be present, the liquor will have an azure blue tint. The am-
moniacal liquid should yield, by evaporation, no fixed residuum.

PHYSIOLOGICAL EFFECTS. (a.) On vegetables.—Sir H. Davy (Agricult.
them. 4th ed. 186) ascribes the sterility of a soil to the presence of sul-
phate of iron.

(b.) On animals.—C. G. Gmelin (Vers. ü. d. Wirk. &c. 84) found that
two drachms given to a dog caused vomiting only; that forty grains had
no effect on a rabbit; and that twenty grains, thrown into the jugular
vein of a dog, produced no effect. Dr. Smith (quoted by Wibmer and
by Christison), however, found that two drachms proved fatal to a dog
when taken into the stomach or applied to a wound. Orfila (Toxicol.
Gén.) obtained similar results. The effects were local inflammation and
specific affection of the stomach and rectum. According to Weinhold
quoted by Richter, Ausf. Arzneim. v. 55), the spleen of animals fed with
it becomes remarkable small and compact.
(c.) On man.—This salt acts locally as a powerful astringent, and, when employed in a concentrated form, as an irritant. The latter effect depends on its chemical action on the organic constituents (albumen, &c.) of the tissues. The remote effects of sulphate of iron are analogous to those of other ferruginous compounds, and which have been already described.

Swallowed in small doses it has an astringent operation on the gastro-intestinal mucous membrane, and thereby diminishes the quantity of fluids secreted or exhaled; hence its continued use causes constipation. It blackens the stools like other compounds of iron. It becomes absorbed, and operates on the system as a tonic, stimulant, emmenagogue, and astringent. In large medicinal doses it readily excites pain, heat, or other uneasiness at the pit of the stomach, and not infrequently nausea and vomiting: this is especially the case in irritable conditions of this viscus. In excessive doses it operates as an irritant poison. A girl took, as an emmenagogue, an ounce of it in beer, and was seized, in consequence, with colic pains, constant vomiting and purging for seven hours. Mucilaginous and oily drinks soon cured her (Christison, from Rust's Magazin, xxii. 247).

Uses.—Sulphate of iron is to be preferred to other ferruginous compounds where there is great relaxation of the solid parts with immoderate discharges. Where the long-continued use of ferruginous compounds is required, it is less adapted for administration than some other preparations of iron, on account of its local action on the alimentary canal.

It is employed in lump, powder, or solution, as a styptic, to check haemorrhage from numerous small vessels. A solution of it is applied to ulcerated surfaces, and to mucous membranes, to diminish profuse discharges; as in chronic ophthalmia, leucorrhæa, and gleet.

Internally it is administered in passive haemorrhages, on account of its supposed astringent influence over the system generally: also in immoderate secretion and exhalation; as in humid asthma, chronic mucous catarrh, old dysenteric affections, colliquative sweating, diabetes, leucorrhæa, gleet, &c. In intermittents it has been employed as a tonic. It has also been found serviceable against tape-worm. Its other uses are the same as the ferruginous compounds generally (vide p. 536).

Administration.—The dose of it is from one to five grains, in the form of pill. If given in solution the water should be recently boiled, to expel the atmospheric air dissolved in it; the oxygen of which converts this salt into a persulphate. For local purposes, solutions of it are employed of various strengths, according to circumstances. In chronic ophthalmia we may use one or two grains to an ounce of water: as an injection in gleet, from four to ten grains.

Fer'ri Car'bonas.—Carbonate of Iron.

History.—This compound must not be confounded with the sesquioxide of iron, which is frequently termed carbonate of iron.

Natural History.—It occurs native in the crystallized state, constituting the mineral called spathose iron. It is also found in most chalybeate waters (vide p. 145.)

Preparation.—It is prepared by adding a solution of an alkaline carbonate to a solution of a protosalt (as the sulphate) of iron, the atmos-
The carbonate of the protoxide of iron is precipitated. When we attempt to collect and dry it, decomposition takes place; oxygen of the air is absorbed, carbonic acid escapes, and sesquioxide of iron remains (ferri sesquioxydum, Ph. L. vide p. 538). Hence when employed in medicine it must be prepared extemporaneously.

**Properties.**—Native protocarbonate of iron is yellow: the primary form of its crystals is the obtuse rhombohedron. Carbonate of iron prepared as above directed is a white precipitate, which by exposure to the air becomes at first greenish, then brown (sesquioxide). It is insoluble in water, but dissolves in sulphuric or hydrochloric acid with effervescence. It also readily dissolves in carbonic acid water: the acidulo-chalybeate waters are natural solutions of this kind (vide p 145.)

**Characteristics.**—It dissolves in diluted sulphuric acid with effervescence. The solution possesses the before-mentioned properties of the ferruginous solutions (vide p. 533).

**Composition.**—Carbonate of the protoxide of iron is thus composed:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt.</th>
<th>Per Cent.</th>
<th>Stromeyer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protoxide of Iron</td>
<td>1</td>
<td>36</td>
<td>62</td>
</tr>
<tr>
<td>Carbonic Acid</td>
<td>1</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>Carbonate of Iron</td>
<td>1</td>
<td>58</td>
<td>100</td>
</tr>
</tbody>
</table>

**Physiological Effects.**—It is one of the most valuable of the ferruginous compounds, on account of the facility with which it dissolves in the fluids of the stomach and becomes absorbed. Its local effects are very mild.

*Mixtura Ferris Composita*, Ph. Lond. and Dubl. (Myrrh, powdered, 3ij; carbonate of potash, 5ij; rose-water, f3xvij.; sulphate of iron, powdered, 3ijss.; spirit of nutmeg, f3ij.; sugar, 5ij. Rub together the myrrh with the spirit of nutmeg and the carbonate of potash, add to these, while rubbing, add first the rose-water with the sugar, then the sulphate of iron. Put the mixture immediately into a proper glass vessel, and stop it).—This is a professed imitation of Dr. Griffith's celebrated antihectic or tonic mixture (Dr. M. Griffith, *Observ. on the Cure of Hectic and Slow Fevers, and the Palm. Consump. 1776*): hence is frequently termed Griffith's Mixture (*mixtura Griffithii*).

In the preparation of it, double decomposition takes place: by the usual reaction of carbonate of potash and sulphate of iron we obtain sulphate of potash, which remains in solution, and carbonate of protoxide of iron, which precipitates. To prevent the latter attracting more oxygen, it is to be preserved in a well-stoppered bottle. As more carbonate of potash is used than undergoes decomposition, the excess combines with the myrrh, and forms a kind of saponaceous compound, which assists in suspending the carbonate of iron in the liquid.

When first made, this mixture has a greenish colour, owing to the ferruginous carbonate; but by exposure to the air it becomes reddish, owing to the absorption of oxygen, by which sesquioxide of iron is formed; and carbonic acid evolves: hence it should only be prepared when required for use.

It is one of the most useful and efficacious ferruginous preparations, and which is supposed to be owing to its being readily soluble, and con-
sequently easy of digestion and absorption. Its constitutional effects are analogous to those of the ferruginous compounds in general, and which have been already described. Its tonic and stimulant operation is promoted by the myrrh: the excess of alkaline carbonate must not be forgotten in estimating the sources of activity of this medicine.

It is admissible in most of the cases in which ferruginous remedies are indicated; but it is especially serviceable in anaemia, chlorosis, atonic amenorrhoea, and hysterical affections. It is also employed with benefit in the hectic fever of phthisis and chronic mucus catarrhs. It is contra-indicated in inflammatory conditions of the gastro-intestinal membrane.

The dose of it is one or two fluidounces threc or four times a day. Of course acids and aciddulous salts, as well as all vegetable astringents which contain gallic or tannic acid, are incompatible with it.

Pillule Ferri Composite, Ph. Lond. and Dubl. (Myrrh, powdered, 3ij.; carbonate of soda; sulphate of iron; treacle, aa 3j. Rub the myrrh with the carbonate of soda; then, having added the sulphate of iron, rub them again; afterwards beat the whole in a vessel previously warmed, until incorporated).—This preparation is analogous in its composition, effects, and uses, to the preceding one. Double decomposition takes place between the two salts employed, and the products are sulphate of soda and carbonate of iron. The carbonate of soda is preferred to the carbonate of potash, on account of the deliquesence of the latter. These pills, like the mixture, should only be made when required for use.

Twenty grains of this compound contain about one grain of protoxide of iron, or 1/2 of grs. of protocarbonate. The effects and uses are precisely the same as the mistura ferri composita. The dose is from ten to twenty grains.

Carbonated Chalybeate Waters.—A most agreeable and efficacious mode of administering carbonate of the protoxide of iron is in the form of the carbonated chalybeate waters, as those of the Islington Spa, near London, of Tunbridge Wells, of Oddy’s saline chalybeate at Harrowgate, and of the Spa in Belgium. The last-mentioned water contains a considerable excess of carbonic acid (vide p. 145). A convenient extemporaneous mode of administering carbonate of iron in imitation of these waters, is by intimately mixing equal parts (as 10 or 12 grains) of sulphate of iron and sesquicarbonate of soda, and dissolving in a tumblerful of carbonic acid water (soda water of the shops): the solution is to be taken in a state of effervescence.

Potassâe Fer'ro-Tar'tras.—Fer'ro-Tar'trate of Pot'ash.

History.—This preparation was first described by Angelus Sala at the commencement of the seventeenth century. It is sometimes termed chalybeated tartar (tartarus chalybeatus seu ferratus), tartarized iron (ferrum tartarizatum); ferri tartarum, Ph. Ed.; tartras potassae et ferri, Ph. Dub.; ferri potassio-tartras, Ph. Lond.

Preparation.—Soubeiran (Nouv. Traité de Pharm. ii. 486) directs it to be prepared thus:—Boil together one part of powdered bitartrate of potash, six parts of water, and as much moist hydrated sesquioxide of iron as the liquid will dissolve. Filter and evaporate to dryness by a gentle heat.
The London Pharmacopoeia professes to follow Soubeiran’s process, at the formula which is given is much more complex; it is as follows:—Mix three ounces of sesquioxide of iron with half a pint of drochloric acid, and digest for two hours in a sand bath. Add to these two gallons of water, and set aside for an hour; then pour off the pernament liquid. Four pints and a half, or as much as may be sufficient, of solution of potash being added, wash what is precipitated gently with water, and, while moist, boil it with eleven ounces and a half of bitartrate of potash, previously mixed with a gallon of water. The liquor should be acid when tried by litmus, drop into it solution of squicarbonate of ammonia until it is saturated. Lastly, strain the liquor, and with a gentle heat let it evaporate, so that the salt may main dry.

The theory of this process is as follows:—By the reaction of sesquioxide of iron and hydrochloric acid we obtain water and sesquichloride iron (vide p. 541). On the addition of caustic potash, the sesquichloride is decomposed, hydrated sesquioxide of iron is precipitated, and chloride of potassium is left solution. These changes are illustrated by the following diagram:

**RESULTS.**

1. Potash 144  
   3 eq. Potassium 120  
   3 eq. Chloride Potassium 228

2. Sesquichloride 53 eq. Chlorine 108
   Iron 164  
   2 eq. Iron 56  
   (Hydrated Sesquioxide of Iron)

3. Water

When the hydrated sesquioxide of iron is boiled with bitartrate of potash, one equivalent or 40 parts of sesquioxide combine with one equivalent or 66 parts of tartaric acid of the bitartrate of potash, and form an equivalent or 106 parts of tartrate of sesquioxide of iron, which combine with an equivalent or 114 parts of tartrate of potash, to form the equivalent or 220 parts of ferrotartrate of potash.

**RESULTS.**

1. Sesquioxide of Iron 140
   1 eq. Tartrate of Sesquiox. Iron 106

2. Bitartrate 1 eq. Tartaric Acid 66
   1 eq. Ferro-tartrate of Potash 114

   1 eq. Tartrate Potash 220

The processes of the Dublin and Edinburgh Colleges are much superior to the above, and need not be minutely described. A mixture of iron, bitartrate of potash, and water, is exposed to the air, by which the iron is converted into sesquioxide, and combines with the bitartrate.

**Properties.**—It is an olive-brown inodorous powder, with a styptic taste. It reacts on vegetable colours, mildly alkaline. It is slightly liquefiable, probably from the tartrate of potash which it contains. It dissolves in about four times its weight of water, and slightly in alcohol.

**Characteristics.**—Ferrocyanide of potassium does not occasion any colour with it, unless a few drops of acid be added. Potash, soda, and their carbonates, do not decompose it at ordinary temperatures, nor does ammonia or its carbonate even by the aid of heat. Tincture of nutgalls uses a dark-coloured precipitate. Sulphuric, nitric, or hydrochloric acid, throws down the sesquioxide of iron from a solution of this salt; excess of acid redissolves it: the solution has then a very astringent taste. Tartaric acid causes the formation of crystals of tartar. Heated a covered crucible, ferrotartrate of potash yields charcoal, carbonate potash, and protoxide of iron.
Composition.—The following table exhibits the composition of this salt, according to Soubeiran (op. cit.) and Phillips (Transl. of Pharmacopoeia).

<table>
<thead>
<tr>
<th></th>
<th>Phillips.</th>
<th>Soubeiran.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tartrate of Sesquioxide of Iron</td>
<td>106 48-18</td>
<td>45</td>
</tr>
<tr>
<td>Tartrate of Potash</td>
<td>114 51-82</td>
<td>55</td>
</tr>
<tr>
<td>Ferro-tartrate of Potash</td>
<td>220 100-00</td>
<td>100</td>
</tr>
</tbody>
</table>

Soubeiran says it contains 13 per cent. of sesquioxide of iron; whereas, according to Mr. Phillips, the quantity is 18-18 per cent.

The ferro-tartrate of potash is to be regarded as a double salt, in which tartrate of iron is the acid or electro-negative ingredient, and tartrate of potash the basic or electro-positive constituent. On this view, we comprehend why ferrocyanide of potassium and the alkalies refuse to act on it in the way they do on the ordinary ferruginous salts, until an acid be added. Geiger (Handb. d. Pharm.) regards it as a combination of tartrate of iron and ferrate of potash.

Purity.—In commerce we frequently meet with an imperfectly prepared compound, in which none or only part of the sesquioxide of iron is in chemical combination with bitartrate of potash. In this state it is only partially soluble in water, and the solution strikes a blue colour with the ferrocyanide of potassium, and throws down a reddish-brown precipitate with solution of potash.

Physiological Effects.—In its effects on the system it agrees, for the most part, with other ferruginous compounds. Its taste, however, is comparatively slight, its astringency is much less than the sulphate or sesquichloride, and consequently its constipating effects are not so obvious, and its stimulant influence over the vascular system is said to be somewhat milder. These peculiarities in its operation are supposed to depend on the tartaric acid and potash with which it is in combination.

Uses.—It is not frequently employed, yet it is a very eligible preparation of iron, and may be employed wherever the ferruginous tonics are indicated.

Administration.—The dose of it is from ten grains to half a drachm, in the form of solution or bolus, combined with some aromatic.

Ammo'nia Fer'ro-tar'tras.—Fer'ro-tar'trate of Ammo'nia.

This salt, commonly termed tartrate of iron and ammonia, or ammonio-tartrate of iron, is occasionally employed in medicine. It was first noticed by Mr. Aikin (Lond. Med. Gaz. viii. 438).

It may be prepared by adding caustic ammonia to a solution of tartrate of iron (prepared by digesting together, for two or three days, one part of tartaric acid, dissolved in hot water, with two or three parts of iron filings). The green solution thus obtained is to be evaporated to dryness by a gentle heat (Aikin, op. cit.)

It is in the form of shining brittle fragments of a deep red colour, not very unlike pieces of very deep-coloured shell-lac. It is very soluble in water. Its taste is strongly saccharine.

Its general effects are analogous to those of the other ferruginous compounds, except that it has very little of any astringency. Its advan-
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pages over other chalybeates are its ready solubility in water, its palatable taste, and the facility with which it may be mixed with various saline substances, without undergoing decomposition. It contains more oxide of iron than the same quantity of sulphate. The dose for an adult is five or six grains in powder, pill, or solution. It may be exhibited in porter without being detected by the taste. It may be added to the compound decoction of aloes without suffering decomposition.

Fer'ri Acet'as.—Acetate of Iron.

History.—A solution of iron in acetic acid has long been known and used in the arts. It constitutes the iron liquor of the dyer.

Preparation.—In the Dublin Pharmacopoeia acetate of iron is directed to be prepared by digesting, for three days, one part of carbonate of iron (sesquioxide) in six parts of acetic acid, and then filtering.

Properties.—It is a deep-red liquid, having an acid chalybeate taste. It reddens litmus.

Characteristics.—When heated, it yield acetic acid. Ferrocyanide of potassium strikes a blue colour with it; infusion of galls a purplish black.

Composition.—It consists of the acetate of the protoxide and acetate of the sesquioxide of iron.

The Physiological Effects and Uses are the same as other ferruginous compounds. The Dose is from ten to twenty-five drops, in water.

Ferri Acetatis Tinctura, Ph. Dubl. (Acetate of potash, two parts; sulphate of iron, one part; rectified spirit, 26 parts. Rub together the acetate and sulphate, then dry, and add the spirit. Digest for seven days, then filter.)—In this process sulphate of potash and acetate of iron are formed: the latter, as well as the excess of the acetate of potash, dissolves in the spirit. It is a claret-coloured tincture. It possesses the usual properties of a ferruginous compound. It is said to be an agreeable chalybeate, and was introduced into the Dublin Pharmacopoeia by Dr. Percival. The dose is from half a drachm to a drachm.

Tinctura Acetatis Ferri cum Alcohol, Ph. Dubl. (Sulphate of iron; acetate of potash, $\frac{3}{3}$ ; alcohol, $\frac{1}{3}$xxij. Triturate together the sulphate and acetate, then dry, and when cold add the alcohol. Digest for twenty-four hours.)—The dose is twenty drops to a drachm.

Order 27.—Binoxide of Manganese.

Mangane'sii Binox'yduum.—Binox'ide of Man'ganese.

History.—Native binoxide of manganese has been long known and used in the manufacture of glass (magnesia vitriaviorum); but until Kaim, in 1770, succeeded in extracting a peculiar metal from it, it was usually regarded as an ore of iron. It is commonly termed native black or peroxide of manganese, or for brevity manganese.

Natural History.—The oxide of manganese used in chemistry and pharmacy is the native anhydrous binoxide, called by mineralogists pyrohusile. It is found in great abundance in Cornwall, Devonshire, Somersetshire, and Aberdeenshire, from whence most of what is met with
in commerce in this country is obtained. The principal mines of it are in the neighbourhood of Launceston, Liloan, and Exeter. The Upton Pyne mine, once celebrated for its oxide of manganese, has yielded scarcely any for several years past, if, indeed, it be not completely worked out. Pyrolusite is also found in Saxony, Hungary, France, and other countries of Europe.

Preparation.—Native binoxide of manganese after being raised from the mine is broken into small pieces, about the size of peas, and then washed to separate the earthy impurities. It is afterwards ground in mills to an impalpable powder.

Properties.—This mineral occurs massive, columnar, crystallized, and pulverent: the primary form of the crystals is the right rhombic prism. The massive variety has sometimes a metallic lustre, but is generally dull and earthy: its colour is iron black or brownish: it soils the fingers in handling it: its sp. gr. varies from 4'6 to 4'9: it is tasteless, odourless, and insoluble in water: it yields a black powder.

Characteristics.—When heated it yields oxygen gas. Mixed with common salt and sulphuric acid it gives out chlorine. Heated with sulphuric acid it evolves oxygen, and forms a sulphate of the protoxide of manganese. It is fusible before the blow-pipe; dissolves in fused borax with effervescence, and colours the globule of an amethystine colour. If it be digested in hydrochloric acid until chlorine cease to be evolved, and the solution slightly supersaturated with ammonia, we get rid of the sesquioxide of iron: the filtered liquid throws down a white precipitate with ferrocyanide of potassium.

Composition.—Pure binoxide of manganese has the following composition:

<table>
<thead>
<tr>
<th>Eq.</th>
<th>Eq.Wt</th>
<th>Per Cent.</th>
<th>Forchhammer</th>
<th>Berzelius &amp; Arfwedson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td>1</td>
<td>28</td>
<td>63'5</td>
<td>63'75</td>
</tr>
<tr>
<td>Oxygen</td>
<td>2</td>
<td>16</td>
<td>36'5</td>
<td>36'25</td>
</tr>
</tbody>
</table>

Binoxide of Manganese 1 44 100'0 100'00 100'00

The native binoxide is, however, never pure: it usually contains oxide of iron, carbonate of lime, sulphate of baryta, and argillaceous matter. Its purity is judged of by the quantity of oxygen or of chlorine which it is capable of yielding. The brown varieties are inferior to the black ones.

Physiological Effects.—The effects of this substance are imperfectly known. Kapp (Hufeland's Journ. Bd. xix. St. 1, S. 176) first employed it internally. He regards it as a permanent stimulant, and says it promotes the appetite and digestion. Vogt (Pharmakodynamik) places it among the tonics, and considers it to be intermediate between iron and lead, but his views are altogether theoretical, as he does not seem to have employed it. Dr. Coupar (Brit. Ann. of Med. Jan. 13, 1837, p. 41) has described several cases of disease which took place among the men engaged in grinding it at the chemical works of Messrs. Tennant and Co. in Glasgow: from these it appears, when slowly introduced into the system, to produce paralysis of the motor nerves. The disease commences with symptoms of paraplegia. It differs from lead in not causing colica pictaetum or constipation, and from mercury in first affecting the lower extremities, and in not exciting tremors of the affected part. C. G. Gmelin (Versuche ü. d. Wirkungen, &c.) tried the effect of the sulphate of the protoxide of manganese on animals, and found that it
caused vomiting, paralysis, without convulsions, and inflammation of the stomach, small intestines, liver, spleen, and heart. Gmelin observes, as remarkable, "the extraordinary secretion of bile produced by it, and which was so considerable that nearly all the intestines were coloured yellow by it, and the large intestines had a wax yellow colour communicated to them," (op. cit. 90.) It deserves notice, in connexion with this effect, that the sel désopilant of Rouvière, used as a quack remedy to evacuate bile, contains chloride of manganese. (Journ. de Chim. Méd. 534.)

Dr. Thomson has seen an ounce of the sulphate swallowed without any effect, except the free action of the bowels. (Coupar, op. cit.) Hünfeld (Horst Archiv f. Med. Erf. 1830, quoted by Wibmer, Wir. d. Arzn.) gave to a rabbit nearly two drachms of manganous acid, in three days, in doses of ten or fifteen grains. The only obvious effect was increased secretion of urine. The animal being killed, the peritoneum and external coat of the colon was found of a greenish colour [protoxide of manganese as green], the muscles were readily lacerated and pale, the liver was unflamed, the bile increased. Wibmer (op. cit.) gave six grains daily of the carbonate of the protoxide of manganese to a rabbit during many weeks. No disturbance of function was observed. The animal was killed, but neither in the blood nor the muscles could the least trace of manganese be detected.

Uses.—It is rarely employed in medicine. Kapp (op. cit.) administered it, as well as the salts of manganese, internally as well as externally in the various forms of syphilis. In herpes, scabies, and the scrobutic diathesis, he used it with benefit. Brera (Harless, Neues Journ. d. Ausl. Med. Lit. Bd. viii. St. 2, S. 57) used it in chlorosis, scrobutus, hypochondriasis, hysteria, &c. Otto (Frorieps Notizen, Bd. xii. No. 22, S. 347) administered it in cachectic complaints with favourable results. Odier (Handb. d. pr. Arzneiwiss. quoted by Richter) employed it in cardialgia. It has been applied as an absorbent in the treatment of old ulcers, as a depilatory, and as a remedy for skin diseases, especially itch and porrigo (Rayer, Treat. on Skin Diseases, by Willis, p. 58.)

Administration.—Internally it has been given in the form of pills, in doses varying from three grains to a scruple, three or four times in the day. As a local agent it has been used in the form of gargle, composed of two or three drachms of the oxide diffused through five or six ounces of barley water. An ointment, consisting of one or two drachms of oxide to an ounce of lard, has also been used.

In chemistry and pharmacy it is employed in the manufacture of oxygen, chlorine, and iodine. In the arts it is used by the bleacher for the production of chlorine; by the glass-maker to destroy the brown colour communicated to glass by iron; and to give an amethystine tint to plate glass; and by the potter for colouring earthenware.

END OF PART I.