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MATERIA MEDICA AND THERAPEUTICS

MATERIA MEDICA

AND

THERAPEUTICS

AN

Introduction to the Rational Treatment of Disease

2650

BY

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AND ON AN EXAMINING BOARD IN ENGLAND
AND EXAMINER IN MATERIA MEDICA IN THE UNIVERSITY OF LONDON
AND IN THE VICTORIA UNIVERSITY

NEW AND ENLARGED EDITION, REVISED THROUGHOUT, AND
CONTAINING THE INDIAN AND COLONIAL ADDENDUM
TO THE BRITISH PHARMACOPŒIA

Forty-seventh Thousand

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PREFACE TO THE PRESENT EDITION.

In the preparation of the present edition the work has been subjected to thorough revision, and brought up to the level of our latest knowledge. An entirely new Part has been added, which contains an account of the materia medica and therapeutics of the drugs in the Indian and Colonial Addendum to the British Pharmacopœia. Another change of some importance, which the author believes will be regarded as an improvement, is the introduction of greater detail respecting the chemical and pharmaceutical relations of the individual drugs. In consequence of these additions and alterations, the work has been enlarged by forty-eight pages.

The author has to thank many friends for valuable advice and assistance. To Dr. John Harold he is under the greatest obligations. Mr. Carter Braine has kindly revised the section on Anæsthetics in the light of recent advances in this important subject. The author again desires to express his gratitude to the many critics who have either publicly or privately communicated to him their opinions of former editions

of this work, and who have been pleased to regard with favour the attempt which has been made in it to render Pharmacology and Therapeutics not only intelligible and rational, but at the same time a more agreeable subject of study to the pupils and practitioners of medicine.

August, 1905.

PREFACE TO THE FIRST EDITION.

THIS book is chiefly therapeutical in its scope, and is intended to be a rational guide to the student and practitioner of medicine in the treatment of disease. At the same time the Materia Medica has not been sacrificed. On the contrary, it will be found to be set forth in detail by the adoption of a *natural* and concise arrangement, which presents the subject in such a form that it can be quickly appreciated and easily remembered. The Author attaches importance to the plan which he has adopted in the description of the Special Therapeutics, and which consists in systematically tracing the physiological actions and uses of the different drugs in their passage through the body, from their first contact with it locally until they are eliminated in the secretions. In the part of the Manual devoted to General Therapeutics he has further departed from the ordinary arrangement, by discussing the actions and uses of remedies, not under the headings of artificial groups, but of the physiological systems of the body (digestion, respiration, etc.), so as to conduct the student from facts with which he

is familiar to the great principles of treatment. In using the book the first year's student is recommended to confine his attention to the Materia Medica proper; and under the actions and uses of the drugs, to read only the words printed in thick type.

The Author gratefully acknowledges the valuable assistance which he has received in the preparation of the work from his friends Dr. Quain, Dr. Lauder Brunton, and Dr. Frederick Roberts; from his brother, Dr. William Bruce of Dingwall; from Mr. Woodhouse Braine, who kindly sketched the section on the use of anæsthetics; and from his friend and former class-assistant, Mr. A. C. N. Goldney, who has relieved him of much labour by superintending the pharmaceutical portions, drawing up lists, and compiling the index.

The many standard treatises on Materia Medica and Therapeutics in this and other countries have been freely consulted, especially Nothnagel and Rossbach's "Arzneimittellehre," Husemann's "Arzneimittellehre," the works of Wood and Bartholow, and the useful volumes of Squire and Martindale.

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Materia Medica and Therapeutics.

INTRODUCTION.

Materia Medica and Therapeutics relate to the use of drugs and other natural means in the treatment of disease. The place which these subjects occupy in the Medical Sciences lies, therefore, between Chemistry, Botany, Anatomy and Physiology on the one hand, and Medicine and Surgery on the other hand; while they stand side by side with Pathology, the other stepping-stone from the more purely scientific to the more strictly practical portions of professional education. The student will now be able to turn to account his acquaintance with Chemistry and Biology, and to appreciate the fact that these sciences are the true foundations of all professional knowledge; and when he has reached the end of the volume he may anticipate with some confidence a personal introduction to the treatment of disease.

Let us consider what subjects are comprised under the title "Materia Medica and Therapeutics."

Materia medica is a term applied to the materials or substances used in medicine, their names, sources, physical characters and chemical properties, the preparations made from them, and the doses in which they may be given.

Therapeutics relates to the treatment of disease,

the word signifying healing, from θεραπέυω, *I attend, heal* or *treat*. It includes, therefore, all that relates to the science and art of healing, by the use not merely of the materia medica, but of remedial measures of every kind, including diet, climate, baths, clothing, nursing, and the numerous other means which may be combined to restore health, not the least important being surgical treatment. This definition is too comprehensive for our present purpose, which is concerned with *medicinal therapeutics, i.e.* the uses of the materia medica. When this subject is discussed under the head of each article of the materia medica, as it comes before us in natural order, it is known by the name of the **special therapeutics** of that article. Materia medica and *special therapeutics* will constitute the first, second and third Parts of the work.

When the numerous and complex facts of special therapeutics are collected, examined and grouped, certain broad conclusions may be drawn from them, unfortunately still far from exact, but sufficient to furnish the ground-work for a science of *general therapeutics*. This portion of our subject will be considered in the concluding Part of the work.

Certain other terms, variously related to the preceding, must be defined here.

Pharmacodynamics (φάρμακον, *a drug*, that is, either a medicine or a poison, and δύναμις, *power*) is a convenient name for that part of our subject which relates to the actions of drugs upon the healthy individual, or, in other words, the **physiological actions** of drugs. In the first division of this work the term "actions" simply will be used to express the same meaning.

Pharmacology (φάρμακον, *a drug*, and λόγος, *a discourse*) is a term employed in various senses. With the older writers in Great Britain it is the science

that relates to the chemical and physiological properties of drugs, their selection and preparation, the extraction of their active principles, and the combination of these with others. The word Pharmacology was next used as a convenient term for the whole subject of materia medica and therapeutics. It is now generally employed, instead of "Pharmacodynamics," to designate *the actions of medicines.*

Pharmacy (*φαρμακευτική*) is the name applied to the *art* which corresponds with the *science* of pharmacology, the art of making the preparations ordered by the pharmacologist, and of dispensing the combinations prescribed by the therapeutist. In such a work as the present, the details of pharmacy must be mainly omitted. They have to be learned practically in the dispensary or pharmaceutical laboratory, not by rote from a book.

THE PHARMACOPŒIA.

The number of drugs used from time immemorial is enormous, and comparatively few are now believed to be really useful. In order to separate the valuable drugs from such as are supposed to be worthless, books have been published from time to time by the governments or medical authorities of different countries, which furnish an authoritative description of the drugs generally recognised and used by the profession, and of the preparations made from them, which have thus become *official* or *officinal.* These books are known as *pharmacopœias* (*φάρμακον, a drug*, and *ποιέω, I make*). In Great Britain, Ireland, the Colonies, and India there is the British Pharmacopœia, which provides a fairly accurate list of the drugs and preparations in use at the time of its publication. But as pharmacology is a rapidly advancing science, especially from the direction of chemistry and pharmacodynamics, and as opinion is very unsettled on the subject of therapeutics, the pharmacopœias of different

countries differ greatly; and the pharmacopœia of any given country neither is accepted at the time of its publication as perfect in itself and to be followed as an article of faith, nor remains a correct representation of professional opinion for any great length of time. It is, however, a necessary provision for insuring the purity of medicines supplied to the public, and a valuable medium of communication between the physician and the pharmaceutical chemist. It furnishes them with formulæ for a great variety of preparations of definite composition, and with an immense amount of information respecting drugs which is necessary in selecting these, in combining them and in devising fresh preparations.

PLAN OF THE MATERIA MEDICA.

In the Pharmacopœia the materia medica and its preparations are arranged alphabetically for convenience of reference; a systematic treatise presents them in the following natural order:—

PART I.—THE INORGANIC MATERIA MEDICA.

Group 1. Alkalis and Alkaline Earths.
„ 2. Metals.
„ 3. Non-metallic Elements.
„ 4. Acids.
„ 5. Water and Hydrogen Peroxide.
„ 6. Carbon Compounds.

PART II.—THE ORGANIC MATERIA MEDICA.

Group 1. The Vegetable Kingdom.
„ 2. The Animal Kingdom.

PART III.—INDIAN AND COLONIAL DRUGS.

Each article will be discussed under several distinct and definite headings, which are as follow: The *names* of the drug in Latin and in English, its *chemical formula*, if any, and the *definition of its nature;* its

source; its *characters;* its *composition;* its *doses;* the *preparations* made from it; and its *actions and uses.*

General reference must here be made to each of these headings.

NAMES, NATURE, AND SOURCES OF DRUGS.

These are sufficiently indicated by the above plan in the case of the *inorganic* materia medica. It includes many of the chemical elements, and a great variety of compounds of the same.

Vegetable drugs are derived from entire plants, including fungi and lichens, stems (woods), green tops and twigs, roots and rhizomes, barks, leaves, buds, flowers, parts of flowers and flowering tops, fruits and seeds; and various vegetable products, including fixed and volatile oils, resins, oleo-resins, balsams, gums, gum-resins, inspissated juices and secretions. The *animal* materia medica includes entire animals, portions of animals, and products yielded either during life or after death.

The **pharmaceutical processes for obtaining drugs** from their crude sources will generally be given, and must be learned by the student, who should repeat *practically* for himself as many as possible of the easier methods. Most of these are already familiar to him in chemistry, such as *solution*, *filtration*, *evaporation*, *crystallisation*, *precipitation*, *decantation*, *calcination*, *sublimation*, *distillation*, *destructive distillation*, *digestion* and *washing*. A few specially pharmaceutical processes require to be noticed.

Pulverisation, the powdering of drugs, is done on a large scale in powerful drug-mills. On a small scale it may be done by simple *trituration* (*triturare*, to pound), in the dry state; by *levigation* (*levigare*, to make smooth or fine) or rubbing down with the aid of a little fluid, the resulting paste being afterwards

dried; or by *mediate pulverisation*, in which some very hard substance or medium is mixed with the drug, so as to break up its substance thoroughly. Powdered drugs necessarily require *sifting*.

Elutriation (*elutriare*, from *eluere*, to wash out) consists in diffusing an insoluble powder in water, allowing only the heavier part to settle, and decanting the fluid; allowing this again to settle for a longer time, so as to deposit a second or finer size of powder, and again decanting; and repeating the operation indefinitely until an extreme degree of fineness has been reached.

Lixiviation (*lix*, a lye) is a process of washing an ash or crude mixture of solids, for the purpose of dissolving out the constituents in the form of a lye, or water impregnated with salts.

Granulation is the production of an intimate mechanical combination of several salts and other crystalline bodies in the form of granules, by subjecting a mixture of the dry constituents in a dish or a pan to a heat of between 200° and 220° F. and employing careful manipulation, including assiduous stirring. The granules thus formed are then assorted by sifting, and dried at a temperature not exceeding 130° F.

Maceration, *Percolation*, and certain other pharmaceutical processes of particular importance will be described in connection with *Preparations* (p. 18).

CHARACTERS OF DRUGS.

This part of the description of drugs must be studied practically. The characters of a drug are (1) *physical* and (2) *chemical*. (1) In learning the *physical* characters, the student uses the Manual as his guide, and carefully examines specimens of drugs, noting, with respect to each article, its *general appearance*, whether liquid, solid, crystalline, etc.; its *colour*,

its *weight*, its *smell*, and its *taste* (if non-poisonous). (2) When convenient, his examination of the drug should follow the pharmacopœial account farther, and include the determination of its *chemical* characters, *i.e.* its *pharmaceutical chemistry*, including its *reaction*; its *solubility* in water, alcohol, ether, oils, etc.; and the *effects of heat* on it—volatility, fusibility, etc. The student is expected to know the ordinary *tests* for the salts, including in each instance (*a*) the tests for the *metal*, (*b*) the tests for the *acid*, and (*c*) any *special* test there may be for the compound. In the case of inorganic salts, such as Copper Sulphate, these tests are purely matters of elementary chemistry, with which the student of materia medica is already familiar; and in this work they will therefore be given only in a condensed form at the end of the account of each metallic element and of each acid respectively. The important reactions characteristic of the organic compounds, such as Morphine and Strychnine, will be stated fully under each. Other chemical properties bearing on the pharmaceutical applications of a drug may have to be studied, especially its *incompatibility* with other drugs, which prevents their combination in preparations.

Impurities.—Along with the characters, the student has, in many instances, to note impurities, and the methods of distinguishing substances so like each other as to be very readily confounded. Impurities may be the result of the imperfect selection, preservation, or preparation of drugs, including chemical decomposition of every kind; or of fraudulent adulteration. Similarity is, of course, a matter of accident, but may give rise to serious error.

The tests of purity applied to *inorganic* drugs are mainly such as are familiar to the student of chemistry; and to avoid constant repetition the most common of them will be represented here once for all:

	Impurity	*Detected by:*
1. Impurities derived from the sources of the drug, or formed in the process of manufacture and imperfectly removed	Water	Bibulous paper; dampness; loss of weight by heat
	Organic matter	Blackening on heating
	Sulphuric acid	White precipitate with $BaCl_2$.
	Hydrochloric acid	White precipitate with $AgNO_3$.
	Phosphoric acid	Yellow precipitate with $AgNO_3$, soluble in HNO_3 and in NH_4HO.
	Carbonic acid	Precipitate with lime-water; effervescence with acids
	Sulphurous acid	Zinc and HCl, which yield H_2S.
	Nitric acid	H_2SO_4 and $FeSO_4$, which give a brown ring between the two fluids
	Calcium	White precipitate with ammonium oxalate
	Arsenium	Yellow precipitate with H_2S.
2. Impurities derived from the apparatus used	Metals, especially lead, iron, and copper	Precipitates with $(NH_4)_2S$, or H_2S; and special tests
3. Insufficient strength		Volumetric tests
4. Fraudulent adulterations	Various coloured earths	Non-volatility; insolubility in HNO_3.
	Cheap salts	Various tests
	Starch	Blue colour with iodine
	Sugar	Evaporation; quantitative test
	Chalk	Effervescence with acids

In the case of *organic* drugs, impurities are chiefly to be detected by careful physical examination and special quantitative tests.

COMPOSITION OF DRUGS.

The composition of the inorganic drugs is expressed by their names and formulæ. On the other hand, the organic drugs are frequently highly complex, the chief

proximate principles being the following: Fixed oils, volatile oils, resins, oleo-resins, gums, gum-resins, balsams, pectin, alkaloids, acids, neutral substances, glucosides, starch, sugar, cellulose, albuminous substances, ferments, colouring matters, salts, and extractives. Some of these demand general consideration here.

A *Fixed Oil*, **Oleum**, is extracted by expression (if possible, without the aid of heat) from the seeds or fruits of plants, or from animal tissues. Fixed oils are compounds of fatty acids (oleic $H,C_{18}H_{33}O_2$, palmitic $H,C_{15}H_{31}CO_2$, and stearic $H,C_{17}H_{35}CO_2$, as well as others less common) with the radical glyceryl C_3H_5. With caustic alkalis or metallic oxides they form **soaps**; the metal combining with the acids, and displacing the glyceryl, which is hydrated and becomes glycerin $C_3H_5(OH)_3$.

$$\underset{\text{Sodium Hydrate.}}{3NaOH} + \underset{\text{Glyceryl Oleate (Vegetable Oil).}}{C_3H_5 3C_{18}H_{33}O_2} = \underset{\text{Sodium Oleate (Hard Soap).}}{3NaC_{18}H_{33}O_2} + \underset{\text{Glyceryl Hydrate (Glycerin).}}{C_3H_5(OH)_3}.$$

Volatile Oils; Resins; Oleo-resins; Balsams.—A volatile oil, **Oleum**, is obtained mainly by distillation from entire plants, flowers, fruits or seeds. Most volatile oils are colourless when pure, and highly aromatic. They are of very different composition. The simplest consist of a liquid hydrocarbon or *elæoptene*, generally isomeric or identical with terpene, the hydrocarbon of oil of turpentine $C_{10}H_{16}$; and of an oxydised hydrocarbon, usually a solid crystalline body, or *stearoptene*, like camphor $C_{10}H_{16}O$. Mixed with these in many instances are various resins, fatty and other acids, and other vegetable constituents. A few volatile oils contain sulphur and nitrogen. Volatile oils are only sufficiently soluble in water to communicate their odour and taste to it;

they are soluble in alcohol, ether and chloroform. Further oxydation converts part of a volatile oil into a *resin*, **Resina**, a solid, brittle non-volatile body, insoluble in water, soluble in alcohol, and forming a soap with an alkali; and thus gives rise to an *oleo-resin*, which can be broken up into its two constituents by distillation. Resins or oleo-resins yielding benzoic or cinnamic acids are called true *balsams*.

A *Gum*, **Gummi**, is an exudation from the stems of plants. Gums consist of two rather complex carbohydrates, *arabin* $C_{12}H_{22}O_{11}$, or arabic acid $H_2C_{12}H_{18}O_{10},H_2O$ (or a similar molecule containing other multiple of $C_6H_{10}O_5$), and *bassorin* or *tragacanthin* $C_{12}H_{20}O_{10}$, which play the part of acid radicals, and exist in gums as salts of calcium, magnesium and potassium. Arabin is soluble in water: bassorin is not soluble, but swells into a gelatinoid mass; the whole product being called a *mucilage*. *Pectin*, vegetable jelly, $C_{32}H_{40}O_{28},4H_2O$, occurs in a few medicinal plants, and, like the *mucilage* yielded by several others, is allied to gum. *Gum-resins* are natural or artificial exudations from plants, containing various proportions of gums and resins, or more frequently of gums, resins and volatile oils. When finely powdered, and rubbed with water, gum-resins yield an *emulsion*, in which the fine particles of the undissolved resin are held in suspension by the mucilage or aqueous solution of the gum.

Alkaloids are active nitrogenous principles formed within organic bodies, and may be regarded as compound ammonias. They resemble alkalis in turning red litmus-paper blue, and form salts with acids. As a rule, they are crystalline solids, rarely liquids; sparingly soluble in water, but readily in alcohol, the solution being bitter.

Organic acids of great variety exist in plants, combined with the inorganic bases—such as potassium and calcium, with alkaloids, or possibly free.

Neutral substances are a very large and mixed group, including: the carbohydrates, such as starch, sugars, gums, etc.; albuminous bodies, which occasionally act as ferments; a few bitter principles; and many of the *glucosides.*

Glucosides are chiefly neutral bodies, capable of being decomposed by acids, alkalis or ferments, in the presence of water, into glucose and a second substance which is different in each instance.

The remaining constituents of organic drugs do not call for special notice.

DOSES.

The Pharmacopœia suggests the limits within which the different substances and their preparations may be given to an adult with safety and advantage. These must be carefully learned. The principles of dosage will be discussed presently (page 25).

PREPARATIONS.

The list of preparations made from the drug, with the principal ingredients, strength, and doses of each, will conclude the account of its pharmacy. This subject demands careful consideration.

Most drugs possess such characters that it is absolutely necessary to prepare them for administration. Thus, if we take, as examples, Sulphur, one of the elements; Colocynthidis Pulpa, the dried pulp of a fruit; Jalapa, a tuber; and Cantharis, a dried beetle; it is manifest that few of these could be brought into useful contact with the body in their native form. Preparations must be made from them, and for several reasons we must have a *variety of preparations.* First, as we have just seen, substances are very various. Secondly, a substance may contain several active principles, soluble in different media,

which it may or may not be desirable to extract together or separately. Thirdly, we constantly wish to obtain *combinations* of drugs, so as to increase, diminish, or otherwise modify the action of each, or to obtain combined action. Fourthly, we must provide for variety of administration or application, externally or internally, to act on a limited part or to enter the blood by any of the methods of exhibition to be presently described; and we must also meet the tastes and fancies of patients with respect to pills, powders, etc., as well as the necessities of circumstances.

The following are the different kinds of preparations in the British Pharmacopœia. A complete list of each kind will be found in the classified tables at pages 617–620.

Acetum, *A Vinegar*, is a solution of the active principles of a drug obtained by macerating it (see p. 17) in acetic acid (not vinegar), or by mixing one of its preparations with acetic acid and alcohol.

Aqua, *A Water*, is a very weak simple solution of a volatile substance in distilled water, obtained (1) by distillation of some part of a plant, or (2) of a volatile oil, with water; (3) by solution without distillation; (4) by trituration with twice its weight of Calcium Phosphate and 500 times its volume of Distilled Water and filtering. The fourth method is sanctioned for use in India and other tropical countries, but it is also employed in routine pharmacy in Britain.

Charta, *A Paper*, consists of cartridge paper coated with a compound of an active substance and Solution of India-rubber, much like a plaster.

Collodium, *A Collodion*, is a solution of Pyroxylin in an ethereal compound, intended to form a coating on the skin when painted on and allowed to evaporate rapidly.

Confectio, *A Confection*, conserve or electuary, is a soft, pasty-looking preparation, in which drugs,

generally dry, are incorporated with syrup, sugar or honey.

Decoctum, *A Decoction*, is a solution made by boiling vegetable drugs in water from five to ten minutes, straining and adding water.

Emplastrum, *A Plaster*, is a preparation that adheres when applied to the body, so as to produce either a local or a general effect. Plasters are compounds of an active substance, such as Mercury or Cantharides, with a basis or medium, which consists variously of lead soap, soap, oil and resin, and is intended to be spread on linen, leather or other material.

Extractum, *An Extract*, is a very important kind of preparation, and comprises a number of different classes, as follows :—

1. The simple *Extract*, **Extractum**, is prepared in various ways :—

(*a*) By steeping or boiling a drug with water, straining, and evaporating the product to a soft consistence or to dryness.

(*b*) By macerating or percolating (see p. 18) a drug with alcohol, and evaporating the product either (α) to a soft consistence, or (β) to dryness, or (γ) till a firm extract is obtained by adding Milk Sugar.

(*c*) By proceeding as in (*b*) (γ), after percolation with ether to remove oil from the drug.

(*d*) By heating the expressed juice of a drug to 212° to coagulate the albumen, straining, and evaporating.

(*e*) By evaporating a liquid extract to a syrupy consistence, adding an accurately determined quantity of Milk Sugar, and evaporating further to a given weight.

2. The *Alcoholic Extract*, **Extractum Alcoholicum.**—This name is given to one of the simple extracts prepared by the process given in 1 (*e*).

3. The *Dry Extract*, **Extractum Siccum**, is prepared like a simple extract, with the further step of thoroughly drying and powdering the product, mixing it with one-fourth of its weight of Calcium Phosphate, and further drying and powdering.

4. The *Compound Extract*, **Extractum Compositum**, is prepared like a simple extract of the principal ingredient, with the addition of other drugs before or during the process of evaporation.

5. The *Green Extract*, **Extractum Viride.**—The juice pressed from the bruised plant is heated to 130° F. to coagulate the green colouring matter, which is strained off, passed through a sieve and reserved. The liquid is then heated to 200° to coagulate the albumen, which is separated by filtration and rejected. The filtrate is next evaporated at 140° to a syrupy consistence, the green colouring matter returned, and the whole evaporated down to a soft consistence.

6. The *Liquid Extract*, **Extractum Liquidum**, speaking generally is prepared by: (1) mixing a drug, or a solid extract of it, with alcohol, or water, or both, and setting aside for some hours in a closed vessel; (2) next percolating with alcohol or with water; then (3) evaporating to a soft consistence; and finally (4) adding alcohol. Considerable variety is followed in the details of this pharmaceutical process in some instances. Thus the menstruum with which the drug is first mixed may be boiling water; or water, hydrochloric acid and glycerin; or ether. Percolation may be complicated by the addition of Calcium Hydroxide to the drug, or it may be replaced by simple straining or pressure. The product may have to be filtered, or first heated to 212° and then strained. In one instance the last step consists in the addition of glycerin instead of alcohol. Most important of all, several Liquid Extracts are *standardised* by: (*a*) testing their

alkaloidal strength before the last step; and (*b*) diluting with alcohol or water to a given volume.

Glycerinum, *A Glycerin,* is a solution of a drug in glycerin, with or without the aid of heat.

Infusum, *An Infusion.* There are three classes of infusion :—

1. The simple *Infusion,* **Infusum,** is prepared like ordinary tea by steeping a vegetable substance with water at the boiling-point, for a quarter to one hour in a covered vessel, and straining. Two infusions are made with cold water.

2. The *Acid Infusion,* **Infusum Acidum,** is made like the last preparation with the addition of an acid to the water.

3. The *Compound Infusion,* **Infusum Compositum,** is made like the Infusum, except that several drugs are infused together.

Injectio Hypodermica, *A Hypodermic Injection,* is a strong solution of an active drug for administration with a syringe under the skin.

Lamellæ, *Discs,* are discs of gelatin with some glycerin, containing a fractional quantity of a salt of an alkaloid. They are intended to be placed within the eyelids.

Linimentum, *A Liniment* or Embrocation, is a preparation suitable for application by rubbing, anointing, or painting. All liniments contain either camphor, oil, glycerin, or soap.

Liquor, *A Solution.* Liquores or solutions proper consist of substances other than volatile oils dissolved in water; but the methods of preparing many are complicated, solution being assisted by alcohol, acids, ether, and calcium or other salts.

Liquor Concentratus, *A Concentrated Solution,* is made by moistening a vegetable drug with alcohol and setting aside for some time; then percolating repeatedly, and filtering if necessary. In some

instances water instead of alcohol is employed to dissolve out the active principles—by infusion, decoction, maceration and pressure, or percolation; the product is heated to 180° F. and cooled; alcohol added, and the product filtered.

Lotio, *A Lotion* or Wash, is a solution or mixture for external application by washing or on lint.

Mel, *A Honey*, is a fluid preparation containing a large proportion of honey.

Mistura, *A Mixture*, is prepared by rubbing up various substances in water. The constituents are usually mixed only, not dissolved, the insoluble substances generally being suspended in the water by means of gum, almond powder, or syrup. Some are Compound.

Mucilago, *A Mucilage*, is a solution of a gum.

Oleum, *An Oil* (as a pharmaceutical preparation, not Oleum as a drug), is a solution of a drug in a fixed oil.

Oxymel, *An Oxymel*, is a preparation containing honey and acetic acid and water, or these and an active principle.

Pilula, *A Pill.*—Pills are small spherical or spheroidal bodies, variously composed of extracts, powders, or other active substances, which are first thoroughly mixed together, and made into a uniform consistent mass with some suitable *excipient*, such as syrup of glucose, mucilage, glycerin, soap, confection of roses or powdered liquorice, and then rolled out and divided up into equal portions. Pills are almost all complex. The substances best adapted for giving as pills are such as from some cause cannot be conveniently taken in fluid form, or those intended to act slowly.

Pulvis, *A Powder*, is a compound of dry insoluble drugs reduced to powder and intimately mixed and sifted.

Spiritus, *A Spirit.*—Spirits belong to three classes: (1) *Rectified Spirit* (Alcohol 90 %), and *Brandy.* (2) *Simple Solutions in Rectified Spirit* of volatile substances, including essential oils, in the latter case of the strength of 1 in 10. (3) Complex *Distillates,* each prepared in a special manner.

Succus, *A Juice,* is the expressed juice of a fresh plant, mixed with one-third of its volume of alcohol 90 % to preserve it; allowed to stand seven days, and then filtered. Succus Limonis, Lemon Juice, is not a preparation but a fresh natural product without alcohol.

Suppositoria, *Suppositories,* are conical solid bodies for introduction into the rectum, where they are intended to melt. They are composed of one or more active ingredients and oil of theobroma or gelatin.

Syrupus, *A Syrup,* is a fluid preparation containing a large amount of sugar. Some syrups are very complex.

Tabellæ, *Tablets,* are small flat bits of chocolate, each five grains in weight, containing a minute quantity of an active substance.

Tinctura, *A Tincture,* is a solution of active substances in alcohol, either alone or combined with other solvents. Tinctures may be grouped according to (1) the solvent, (2) the process, or (3) the ingredients employed. These are various:

1. Solvents.—(*a*) Alcohol 45-90 % is chiefly used.

(*b*) **Tinctura Ammoniata,** the ammoniated tincture, is made with Solution of Ammonia in addition to alcohol.

(*c*) **Tinctura Ætherea,** the ethereal tincture, is prepared with Spirit of Ether instead of alcohol.

2. Processes.—Tinctures may be prepared by:—

(*a*) *Simple solution* or mixture.

(*b*) *Maceration:* Place the solid material in the

whole of the menstruum in a closed vessel for seven days, frequently agitating; strain; press the marc; mix the two liquids; and filter if necessary.

(*c*) *Percolation:* Macerate the drug or drugs for 24 hours in part of the menstruum; pack in a percolator, and add fresh portions of menstruum until about three-fourths of the desired quantity is passed through; remove the marc from the percolator, press, and filter the product; mix the filtrate and the percolate, and add fresh menstruum to make the prescribed volume of tincture.

(*d*) Some tinctures are *standardised* (*see* pp. 14-15).

3. INGREDIENTS. — A Tincture may be either *simple*, **Tinctura**; or *compound*, **Tinctura Composita**, that is, may contain more than one active substance.

Trochiscus, *A Lozenge*, is a dry tablet of one or more active ingredients (uniformly divided or previously dissolved) mixed with one or other of four different *bases*, namely: (1) *Fruit Basis*, (2) *Rose Basis*, (3) *Simple Basis*, and (4) *Tolu Basis*. These consist of sugar, gum, mucilage, and (1) black currant paste, and water; (2) Rose water; (3) Water; and (4) Balsam of Tolu, respectively.

Unguentum, *An Ointment*, is a mixture of active substances with lard, hydrous wool fat, benzoated lard, suet, spermaceti, wax, oil, or hard or soft paraffin, variously combined. The ingredients are either thoroughly mixed or melted together.

Vinum, *A Wine*, is either: (1) a solution of a drug, whether in sherry or in orange wine; or (2) a wine made by fermentation of a saccharine solution to which a drug has been added.

The following preparations are also in common use, but are not ordered in the British Pharmacopœia:—

Bougie, a Bougie, a solid cylinder of gelatin or cacao-

butter with which a drug is incorporated; for introduction into the nose or urethra. *Cachet*, a Cachet, a lenticular capsule of wafer paper, containing a nauseous or insoluble drug. *Capsula*, a Capsule, a receptacle commonly made of gelatin, containing a nauseous or insoluble drug, whether solid or liquid. *Cataplasma*, a Poultice, a familiar preparation for external application. *Collyrium*, an Eye-wash. *Elixir*, an alcoholic aromatic syrup. *Emulsion* (*see* page 10). *Enema*, an Injection or Clystera, a liquid for injection *per rectum*. *Essentia*, a concentrated alcoholic solution of a volatile oil. *Gargarisma*, a Gargle. *Guttæ*, liquids for instillation into the eye. *Haustus*, a Draught. *Insufflatio*, a powder to be blown into the throat. *Nebula*, an atomised spray. *Linctus*, a Linctus, a thin confection slowly swallowed in small doses to affect the throat. *Pastillus*, a Pastil, a soft lozenge containing glycerin and gelatin as its basis. *Pessus*, a Pessary, a large variety of suppository administered *per vaginam*. *Pigmentum*, a solution to be painted on a part. *Vapor*, an Inhalation; administered as a vapour or gas disengaged on union of the ingredients.

WEIGHTS AND MEASURES: SIGNS AND SYMBOLS.

The weights of the British Pharmacopœia are (1) those of the Imperial system; (2) those of the Metric system.

1. Imperial system.

Measures of Mass.

These are the grain, *granum;* the ounce (avoird.), *uncia;* and the pound, *librum;* with their conventional symbols, gr., ℥, and lb. respectively.

1 grain = *granum*, gr. j.
1 ounce = *uncia*, ℥j = 437·5 grains.
1 pound = *librum*, lb. j = 16 ounces = 7000 grains.

It is very common, however, and optional in prescribing, to employ two weights between the grain and the ounce, called respectively the scruple, *scrupulum*, ℈, to represent 20 grains, and the drachm, *drachma*, ʒ, to represent 60 grains.

Measures of Capacity.

The measures of capacity of the British Pharmacopœia and their symbols are the minim, *minimum*, min., or ♏; the fluid drachm, *drachma fluida*, fl.dr., *f*ʒ, or simply ʒ; the fluid ounce, *uncia fluida*, fl.oz., *f*ℨ, or simply ℨ; the pint, *octarium*, O; and the gallon, *congius*, C.

1 minim	= min. j, ♏j.
60 minims	= 1 fluid drachm, fl.dr.j., *f*ʒj, ʒj
8 fluid drachms	= 1 fluid ounce, fl.oz.j., *f*ℨj, ℨj.
20 fluid ounces	= 1 pint, Oj.
8 pints	= 1 gallon, Cj.

RELATION OF VOLUME TO MASS.

1 minim	is the volume at 62°F. of	0·9114	grain of water
1 fluid drachm	„ „	54·6875	grains „
1 fluid ounce	„ „	1	oz., or 437·5 grs. of water
1 pint	„ „	1·25	lb., or 8750·0 „ „
1 gallon	„ „	10	lbs., or 70000·0 „ „

2. Metric system.

Measures of Mass.

1 milligramme	= the thousandth part of 1 gramme	=	0·001 grm.
1 centigramme	= the hundredth „ „	=	0·01 „
1 decigramme	= the tenth „ „	=	0·1 „
1 gramme	= weight of 1 millilitre of distilled water at 4° C.	=	1·0 „
1 dekagramme	= ten grammes	=	10·0 „
1 hectogramme	= one hundred grammes	=	100·0 „
1 kilogramme	= one thousand „	=	1000·0 „

Measures of Capacity.

1 millilitre	= the volume at 4° C. of	1	grm.	of water
1 centilitre	= „ „	10	„	
1 decilitre	= „ „	100	„	
1 litre	= „ „	1000	„	(1 kilog.)

RELATION OF CUBIC MEASURES TO MEASURES OF CAPACITY.

1 cubic centimetre	= 0·99984 millilitre
1 cubic decimetre	= 0·99984 litre, or 1000 cub. centim.

RELATION OF THE IMPERIAL STANDARDS TO THE METRIC STANDARDS.

Standards of Mass.

1 pound	=	453·5925	grammes nearly
1 ounce	=	28·3495	„ „
1 grain	=	0·0648	„ „

and conversely:

1 milligramme = 0·015 grain nearly
1 centigramme = 0·154 „ „
1 decigramme = 1·543 „ „
1 gramme = 15·4323564 grains
1 kilogramme = 2 lbs. 3 oz., 119·85 gr. = 15432·3564 grains

Standards of Capacity.

1 gallon	= 4·545963 litres				
1 pint	= 0·5682454 „	=	568·336	c. centim.	nearly
1 fluid ounce	= 0·0284123 „	=	28·417	„	„
1 fluid drachm	= 0·003552 „	=	3·552	„	„
1 minim	= 0·000059 „	=	0·059	„	„

and conversely:

1 cubic centimetre = 16·9 minims nearly
1 litre = 1·7598 pint = 1 pint 15 fl.oz. 1 fl.dr. 34 min.

In all Pharmacopœial Preparations described in this *Manual*, where the *relative* (not actual) amounts of the ingredients are stated, the Metric system is followed; otherwise, solids are measured by mass, liquids by capacity, according to the Imperial system.

Domestic measures.—A *teaspoonful* is a convenient but not quite accurate measure of 1 fluid drachm; a *dessert-spoonful*, of 2 fluid drachms; a *table-spoonful*, of half a fluid ounce; a *wineglassful*, of 1½ to 2 fluid ounces; a *teacupful*, of 5 fluid ounces; a *breakfastcupful*, of 8 fluid ounces; a *tumblerful*, of 10 to 12 fluid ounces. Wherever accuracy is desired, a graduated measure glass must be used. Some drops being twice as large as others, it is dangerous to order "drops" of powerful remedies, especially for children.

ACTIONS AND USES OF DRUGS.

The preceding subjects complete the kinds of information furnished by the Pharmacopœia. The student must next make himself acquainted with the actions and uses of each drug, that is, its pharmaco-

dynamical and therapeutical relations. In the following pages this portion of the subject will be discussed under four heads, according to the order in which the drug affects the different parts of the body, namely :—

1. **Immediate local actions.**—When a medicine is applied to an exposed surface, it may produce some effect or "act upon" it. This may occur either *externally*, *i.e.* on the skin or exposed mucous surfaces, such as the conjunctiva, anterior nares, vagina, etc. ; or *internally*—on the alimentary canal, especially the stomach and intestines, including the rectum, *e.g.* emetics and purgatives. Some drugs have no further action.

2. **Actions in or on the Blood.**—The great majority of active remedies are absorbed into the blood, and enter into the composition of its plasma, much less frequently of the red or white corpuscles ; that is, have an effect *in* it, but little or no action *on* it. The student must carefully note that few medicines produce their characteristic effect by acting on the blood.

3. **Specific actions.**—Leaving the circulation, drugs enter the tissues and organs, alter the anatomical and physiological state of one or more of them, and are then said to have a *specific* action upon these, *e.g.* Alcohol on the brain. Usually this is the characteristic and most important action of the drug.

4. **Remote local actions.**—Medicinal substances, having passed through the tissues, are finally cast out of the body by the excreting organs, whether in the same form as they were admitted, or as the products of decomposition in the system. The kidneys are the great channel of escape for drugs ; the lungs ("breath"), skin, mouth, liver, bowels, mammary glands, and all mucous surfaces and wounds eliminate them to a less extent. Whilst thus passing through

the excreting organs, a drug may not only alter their secretions but exert further or remote local actions on their tissues, not infrequently resembling their immediate local actions.

PRESCRIBING.

When the practitioner desires to employ drugs for the purposes of treatment, he turns to his knowledge of the actions and uses of the materia medica, selects his remedies, and proceeds to order one or more of them, according to a recognised form or formula, which is called a *prescription.* This is a very difficult proceeding when first attempted, being nothing less than a serious and probably sudden practical test of one's acquaintance with an enormous subject. The beginner should know, therefore, what points are specially to be kept before him in these circumstances. Briefly, they may be said to be the following :

1. **Selection of the remedy.**—This is, of course, the first and fundamental proceeding of all. It is intended to be the rational result of as accurate a knowledge as can be gained of the disease which has to be remedied or relieved, and of the means at our command of doing so. How this choice is to be made will be discussed under General Therapeutics in the fourth Part of the work.

Idiosyncrasy.—Before finally deciding, however, on certain drugs, idiosyncrasy must not be forgotten ; that is, the peculiar susceptibility of some individuals to the actions of particular medicines, such as opium, mercury, quinine, the iodides and ipecacuanha. In almost every instance such idiosyncrasy means *increased* susceptibility : unpleasant or even dangerous results follow an ordinary or even a minute dose. It is well, therefore, before ordering such drugs, to

inquire whether the patient has taken them previously, and if not, to use them cautiously at first.

2. **Selection of the preparation.**—The drug having been determined, the particular preparation of it will be selected in accordance with the considerations discussed under that heading. We have seen that the Pharmacopœia affords abundant choice, according to the channel by which it is to be administered. This naturally leads us to consider the

MODES OF ADMINISTRATION OF DRUGS.

The activity of a drug may vary greatly with the channel by which it is introduced, *i.e.* with the readiness or rapidity of its absorption into the circulation.

(*a*) By the *skin*, or mucous membrane continuous with the skin, whether simply applied or rubbed in (liniments, ointments); painted on (pigments, etc.); worn on the skin (as a plaster or ointment); applied in a state of fine division by fumigation, with or without sweating; used as a gargle, injection, or wash; or insufflated on to a part. The effect desired is usually local only, but it may be general, many drugs being absorbed by the skin or exposed mucous membrane.

(*b*) By the *mouth*, to act locally on the alimentary canal, and to be absorbed from it, especially from the stomach.

(*c*) By the *rectum* (or *vagina* in the female), in the form of enema or injection (fluid), or of suppository (solid). Drugs may have to be given by the rectum instead of by the mouth, on account of some physical obstacle, repugnance on the part of the patient, or irritability of the stomach; or to spare the stomach in conditions of exhaustion. Again, the action desired may be a local one on the rectum and pelvic organs, *e.g.* to relieve pain, destroy worms or soften retained fæces.

(*d*) By injection under the skin (*subcutaneous or*

hypodermic injection); or into the tissues (*interstitial injection* and *infiltration*) : excellent methods of admitting remedies into the system with certainty and despatch.

(*e*) By *application to wounds* or diseased surfaces, as lotions, dusting powders, gargles, injections, bougies, collyria ; or by the *endermic* method, *i.e.* by being sprinkled on a blistered surface.

(*f*) By *inhalation*, the substances being volatile, and intended either to enter the blood through the pulmonary capillaries, *e.g.* chloroform, or to act directly on the parts to which they gain access in the form of smoke from medicated cigarettes, of insufflated powders, or of medicated watery vapours, sprays, or nebulæ.

(*g*) By *intravenous injection*, rarely practised in man.

3. **The Dose.**—Having selected the remedy and the mode by which it is to be administered, we next determine the dose in which the preparation is to be ordered. The Pharmacopœia indicates the limits of ordinary doses, the minimum being the smallest useful dose with which it may be wise to begin, and the maximum being the largest usually given without special reason and caution. Experience alone can teach the practitioner how far he may safely and wisely depart from these limits, to which he is in no way tied by law. A table of equivalent doses in the two systems will be found on pages 31 and 32. Several modifying circumstances which are to be taken into account with respect to doses must here be carefully noted :

(*a*) Many drugs have *different actions in different doses*, which must be arranged accordingly ; *e.g.* tartar emetic, alcohol, opium and rhubarb.

(*b*) The dose varies with the *age* of the patient, children getting but a fraction of the dose for an adult. A convenient method of calculating doses for *children* of twelve or under, is to divide the age in years by the age in years + 12, and to use the result as the proper

fraction of an adult dose. Thus, for a child of four years the dose will be $\frac{4}{4+12} = \frac{4}{16} = \frac{1}{4}$ of an adult dose; for a child of twelve, $\frac{12}{12+12} = \frac{12}{24} = \frac{1}{2}$. Above twelve, and under twenty-one, the dose lies between $\frac{1}{2}$ and a full dose. It should be mentioned here that some drugs are peculiarly well borne by children, being taken by them in relatively large doses with safety and advantage. The principal of these are Arsenic, Mercury, Chloral Hydrate and Belladonna. On the other hand children are particularly susceptible of the influence of Opium.

Lauder Brunton has formulated a rule for ascertaining the fraction of an adult dose which should be given to a child according to the metric system. This consists in multiplying the adult dose by the age of the child at its *next* birthday divided by 25 (taken as the "adult age"), or multiplied by $\frac{4}{100}$ which is equivalent but more convenient for reckoning. Thus an adult dose of 5 grains (= ·33 gramme) would be for a child of seven years—$\cdot 33 \times \frac{8}{25} = 0{\cdot}1015$ gramme, or more conveniently $\cdot 33 \times \frac{32}{100} = 0{\cdot}1015$ gramme.

(*c*) In particular *diseases* the ordinary dose may have to be modified. In disease of the kidneys, where excretion is diminished, drugs which are discharged by this channel, such as morphine, are retained in the system for a longer time, *i.e.* exist in it in larger quantity at any given time after administration, and symptoms of poisoning very readily supervene. Quite a different matter is the effect of a disease in neutralising the effect of a drug given to combat it. Thus, larger doses of morphine will be tolerated in severe pain, because the action of the morphine is spent in overcoming the pain. The periods of menstruation, pregnancy, and lactation also require to be considered in prescribing.

4. **Frequency.**—Medicines are ordered to be taken one or more times, according to the end desired. Thus, purgatives are generally taken in a single dose; an emetic is to be taken once, and repeated only in case vomiting is not induced; tonics are generally ordered three times a day continuously. The interval between the doses should, as a rule, be such that the second dose may be taken before the effect produced by the first has passed off.

5. **Duration.**—The period for which a drug may be given depends on a variety of circumstances which need not be discussed here. We must refer, however, to *accumulation*, *toleration*, *custom* and *habit*. When a drug is allowed to enter the system at short intervals, for a sufficient period, more rapidly than it is excreted, a time will obviously come when it will have *accumulated* so much in the tissues as to produce its effects in a marked degree. Powerful drugs, *e.g.* strychnine and digitalis, may thus begin to act as poisons after having been given in the same doses with benefit for weeks. On the other hand, certain drugs lose their effect when given for a length of time, from some cause still obscure, *e.g.* opium. The dose must then be steadily increased, *toleration* being said to be established by *custom*. If a patient become dependent on a drug, crave for it, and indulge in it to an unfortunate or even vicious extent, he is said to have developed a *habit* for that drug, such as the opium and alcohol habits or the habitual use of enemata.

6. **Time.**—The times of the day or night at which the doses must be taken are of the first importance; and speaking generally, it may be said that every advantage must be taken in this respect of the natural tendency which it is desired to assist or stimulate by the drug. Thus, drugs which induce sleep are naturally given at bedtime; alkaline stomachics before meals; saline purgatives early in the morning. The

time required by the drug to act must also be calculated, especially in the case of the different purgatives.

7. **Combinations: Chemical and Physiological Incompatibles.**—In most instances more than one drug has to be given at the same time, and the practitioner finds that he must combine them in a single preparation, whether, for instance, pill, powder, or liniment. Successful combination is at once the most important and most difficult part of the art of prescribing. Whilst it affords the prescriber an opportunity of applying the whole of his knowledge of drugs and their actions, it cannot be accomplished without a thorough acquaintance with the physical, chemical, and physiological properties of the ingredients of the proposed compound. The mere appearance, taste, and flavour of a mixture are important points to be considered in ordering it. The chemical reactions which may occur between the constituents must be constantly kept in view. The prescriber may either intend the constituents to remain chemically unchanged, or arrange for the decomposition of one or more of them and the production of a new substance. Drugs which decompose each other are said to be *chemically incompatible* in the widest sense; but the use of the term is commonly restricted to instances in which the result is an unexpected, inelegant, useless or dangerous compound. Thus, if it be desired to give a patient potassium chlorate and hydrochloric acid, we say that the undiluted acid is incompatible with the salt, because chlorine is produced by their combination; but if it be intended to order the patient a fresh solution of chlorine in water, and the decomposition be deliberately planned, the combination would not be considered incompatible.

The prime consideration, however, will be the physiological effect of the combination. This is very different in different cases. Each of the constituents

may be intended to produce an effect different from the others; or to have the same effect; or one or more ingredients may be introduced to modify the action of the principal, that is, to correct some unpleasant, dangerous, or otherwise undesirable influence which it happens to possess in addition to the influence which we wish to secure. Such *correctives* are necessarily physiological antagonists, *i.e.* seem to counteract each other, and appear, therefore, to be *physiological incompatibles;* but it is for this very reason that they are to be combined, because whilst they neutralise the action of each other in certain directions, they are left mutually free to affect other parts of the system. Thus, calomel combined with opium prevents it from causing constipation, whilst it does not interfere with its action on the brain; and the opium, in turn, prevents the calomel from purging the patient, whilst it allows the mercurial to act on the tissues.

8. **The Prescription.**—We are now in a position to analyse a prescription. A prescription consists of five parts: The *superscription*, consisting of a single sign, ℞, an abbreviation for *recipe*, "take"; the *inscription*, or body of the prescription, containing the names and quantities of the drugs ordered; the *subscription*, or directions to the dispenser; the *signature*, or directions to the patient, following *Signa;* and, lastly, the patient's name, the date, and the prescriber's name or initials. In what may be called a classical prescription, it was customary to arrange the constituents of the inscription under four heads, viz. the *basis*, or active drug proper; the *adjuvant*, or substance intended to assist, and especially to hasten, the action of the basis; the *corrective*, to limit or otherwise modify the same; and the *vehicle* or *excipient*, to bring the whole into a convenient, pleasant form for administration.

To take an example:

Superscription	℞
Inscription	Ferri et Ammonii Citratis, gr.v (*basis*). Liquoris Ammoniæ Fortis, min.jss. (*adjuvant*). Spiritûs Myristicæ, min.vj. (*corrective*). Infusi Calumbæ, ad ℥j (*vehicle* or *excipient*).
Subscription	Misce. Mitte doses tales viij. Signa:—
Signature	Two tablespoonfuls twice a day, after meals.

Patient's name..... Practitioner's name or initials.....

Date.....

It will be seen that the first three parts of the prescription are in Latin; the signature or directions to the patient in English. The names of the drugs or preparations are in the genitive case, the quantities standing in the accusative case, governed by *recipe*—

Recipe, Spiritûs Myristicæ, minima sex.

Take, of Spirit of Nutmeg, six minims.

A few *abbreviations* and *signs* are allowed, viz.: ℞ for recipe; *m.*, misce; *S.*, signa; *āā*, ana (*ανὰ*), of each; *ft.*, fiat, make; *q.s.*, quantum sufficit, a sufficiency; *ad*, up to, to amount to (the full phrase being *quantum sufficit usque ad*); *c̄.*, cum, with; *no.*, numero, in number; *p.r.n.*, pro re natâ, as required, occasionally; *rep.*, repetatur, let it be repeated; *ss.*, *ſs.*, semi, or semis, a half.

The names of drugs must always be written in full wherever there can be the smallest possibility of error. It is not only inelegant but dangerous to use such abbreviations as *Acid. Hydroc. Dil.*, and *Hyd. Chlor.*

The various weights and measures are expressed by characters and figures, very rarely by words, placed distinctly at the end of the line occupied by the name of each ingredient; but if two or more consecutive ingredients are ordered in equal quantity, it is usual, instead of repeating this each time, to write it only once after the last of them, preceded by the sign *āā*, of each.

TABLE OF EQUIVALENT DOSES IN THE IMPERIAL AND METRIC SYSTEMS.

I.—Doses according to Weight.

Grain, gr.			Gramme, grm.		
1/200	to	1/100	·00032	to	·00065
1/100	,,	1/25	·00065	,,	·0026
1/100	,,	1/20	·00065	,,	·00325
1/60	,,	1/15	·0011	,,	·0044
1/40	,,	1/10	·0016	,,	·0065
1/80	,,	1/20	·0008	,,	·0032
1/32	,,	1/16	·002	,,	·004
1/24	,,	1/8	·0027	,,	·0081
1/20	,,	1/10	·0032	,,	·0065
1/20	,,	1/5	·0032	,,	·013
1/20	,,	1/2	·00325	,,	·0325
1/16	,,	1/4	·0041	,,	·016
1/10	,,	1/5	·0065	,,	·013
1/10	,,	1/2	·0065	,,	·0325
1/10	,,	1/4	·0065	,,	·016
1/8	,,	1/2	·008	,,	·032
1/5	,,	1/2	·013	,,	·032
1/4	,,	1/2	·016	,,	·032
1/4	,,	1	·016	,,	·065
1/4	,,	2	·016	,,	·130
1/2	,,	1	·032	,,	·065
1/2	,,	2	·032	,,	·130
1/2	,,	3	·032	,,	·195
1	,,	2	·065	,,	·130
1	,,	3	·065	,,	·195
1	,,	4	·065	,,	·260
1	,,	5	·065	,,	·325
2	,,	3	·130	,,	·195
2	,,	4	·130	,,	·260
2	,,	5	·130	,,	·325
2	,,	8	·130	,,	·520
2	,,	10	·130	,,	·650
3	,,	8	·195	,,	·520
3	,,	10	·195	,,	·650
4	,,	8	·260	,,	·520
5	,,	10	·325	,,	·650
5	,,	15	·325	,,	·975
5	,,	20	·325	,,	1·30
5	,,	30	·325	,,	1·95
10	,,	30	·65	,,	1·30
10	,,	30	·65	,,	1·95
10	,,	40	·65	,,	2·60
10	,,	60	·65	,,	3·90
20	,,	30	1·30	,,	1·95
20	,,	40	1·30	,,	2·60
20	,,	60	1·30	,,	3·90
30	,,	60	1·95	,,	3·90

I.—DOSES ACCORDING TO WEIGHT.—*continued.*

Grain, gr.					Gramme, grm.		
60	,,	120	...	...	3·90	,,	7·80
60	,,	240	...	...	3·90	,,	15·6
120	,,	240	...	...	7·80	,,	15·6
Ounce, oz., ℥.							
¼	to	½	...	...	7·1	,,	14·2
½	,,	1	...	...	14·2	,,	28·4

II.—DOSES ACCORDING TO CAPACITY.

Minim, min., ♏.					Cubic centimetre, cc.		
½	to	1	...	...	·030	to	·059
½	,,	2	...	...	·030	,,	·118
½	,,	3	...	...	·030	,,	·178
1	,,	2	...	...	·059	,,	·118
1	,,	3	...	...	·059	,,	·178
1	,,	5	...	...	·059	,,	·296
2	,,	5	...	...	·118	,,	·296
2	,,	6	...	...	·118	,,	·355
2	,,	8	...	...	·118	,,	·474
2	,,	10	...	...	·118	,,	·592
3	,,	10	...	...	·178	,,	·592
5	,,	10	...	...	·296	,,	·592
5	,,	15	...	...	·296	,,	·888
5	,,	20	...	...	·296	,,	1·2
5	,,	30	...	...	·296	,,	1·78
10	,,	20	...	...	·592	,,	1·2
10	,,	30	...	...	·592	,,	1·78
10	,,	40	...	...	·592	,,	2·37
10	,,	60	...	...	·592	,,	3·55
15	,,	20	...	...	·888	,,	1·18
15	,,	60	...	...	·888	,,	3·55
20	,,	30	...	...	1·18	,,	1·78
20	,,	60	...	...	1·18	,,	3·55
30	,,	60	...	...	1·78	,,	3·55
30	,,	120	...	...	1·78	,,	7·1
30	,,	180	...	...	1·78	,,	10·65
40	,,	60	...	...	2·37	,,	3·55
45	,,	90	...	...	2·66	,,	5·33
Fluid drachm, fl.drm., ʒ.							
1	to	1½	...	...	3·55	,,	5·33
1	,,	2	...	...	3·55	,,	7·10
2	,,	4	...	...	7·10	,,	14·2
2	,,	6	...	...	7·10	,,	21·3
2	,,	8	...	...	7·10	,,	28·4
3	,,	4	...	...	10·65	,,	14·2
4	,,	6	...	...	14·2	,,	21·3
Fluid ounce, fl.oz., f℥.							
½	to	1	...	...	14·2	,,	28·4
½	,,	2	...	...	14·2	,,	56·8
1	,,	2	...	...	28·4	,,	56·8

Part I.

THE INORGANIC MATERIA MEDICA.

GROUP I.

THE ALKALIS AND ALKALINE EARTHS.

Of the alkalis and alkaline earths, Potassium, Sodium, Ammonium, Lithium, Calcium, Magnesium and Cerium are official. Barium and Strontium are also occasionally used in medicine.

POTASSIUM. Potassium. K. 38·83.

The salts and preparations of Potassium are derived from five great sources, viz. (1) Wood ashes; (2) Cream of Tartar; (3) the native Nitrate; (4) the crude Sulphate; and (5) the Bichromate. They will be most conveniently discussed in the same order:

1. Potassii Carbonas.—Potassium Carbonate. K_2CO_3. Salt of Tartar.

Source.—Obtained from ashes of wood, or by the interaction of crude Potassium Sulphate and crude Calcium Carbonate and Carbon.

Characters.—A white, crystalline, very deliquescent powder, of caustic and alkaline taste; soluble in its own weight of water, insoluble in alcohol 90 %. 20 gr. neutralise 17 gr. of Citric Acid, or 18 gr. of Tartaric Acid. *Impurities.*—Other metals; sulphates, thiosulphates and chlorides.

Dose.—5 to 20 gr.

Potassii Carbonas is used in preparing: Decoctum Aloes

Compositum, Mistura Ferri Composita, Liquor Arsenicalis, and Unguentum Potassii Iodidi.

From Potassii Carbonas are made:

a. **Potassii Bicarbonas.**—Potassium Bicarbonate. $KHCO_3$.

Source.—Made by saturating a strong aqueous solution of the Carbonate with carbonic anhydride.

Characters.—Colourless monoclinic prisms, not deliquescent; of a saline, feebly alkaline taste; not corrosive. *Solubility.*—1 in 4 of water; insoluble in alcohol 90 %. 20 gr. neutralise 14 gr. of Citric Acid, or 15 gr. of Tartaric Acid. *Impurities*, as of the Carbonate.

Dose.—5 to 30 gr.

b. **Potassa Caustica.** — Potassium Hydroxide. Caustic Potash. Potassium Hydrate. KOH, with not more than 10 % of combined water and impurities.

Source.—Prepared by the interaction of Potassium Carbonate and Calcium Hydroxide.

Characters.—White pencils or cakes, hard but very deliquescent, powerfully alkaline and corrosive. *Solubility.*—2 in 1 of water; 1 in 2 of alcohol 90 %. *Impurities.*—Copper, lead, arsenium.

From Potassa Caustica are made:

α. **Potassii Permanganas.**—Potassium Permanganate. $KMnO_4$. See *Manganesium*, page 91.

β. **Potassii Iodidum.**—Potassium Iodide. KI. See *Iodum*, page 126.

γ. **Potassii Bromidum.**—Potassium Bromide. KBr. See *Bromum*, page 132.

δ. **Liquor Potassæ.**—Solution of Potash. 27 gr. of KOH in 1 fl.oz. of water.

Characters.—A colourless, odourless, strongly alkaline fluid; feeling soapy when rubbed between the fingers. Sp. gr. 1·058. *Impurities.*—Carbonates, giving effervescence with acids; sulphates, and chlorides; other metals. *Dose*, 10 to 30 min., freely diluted.

c. **Potassii Citras.**—Potassium Citrate. $C_3H_4 \cdot OH \cdot (COOK)_3$.

Source.—Made by interaction of Citric Acid and Potassium Carbonate. $3K_2CO_3+2(C_3H_4{\cdot}OH{\cdot}(COOH)_3)=2(C_3H_4{\cdot}OH{\cdot}(COOK)_3)+3H_2O+3CO_2$.

Characters.—A white powder, of saline, feebly acid taste, deliquescent, very soluble in water.

Dose.—10 to 40 gr.

d. **Potassii Acetas.**—Potassium Acetate. $CH_3{\cdot}COOK$.

Source.—Made by saturating Acetic Acid with Potassium Carbonate, evaporating and fusing. $K_2CO_3+2(CH_3{\cdot}COOH)=2(CH_3{\cdot}COOK)+H_2O+CO_2$.

Characters.—White foliaceous satiny masses, or granular particles; very deliquescent; alkaline. The peculiar appearance of this salt is due to crystallisation after fusion. *Solubility.*—2 in 1 of water; 1 in 2 of alcohol 90 %. *Impurities.*—The carbonate, detected by being insoluble in spirit; excess of acid, giving acid reaction; other metals.

Dose.—10 to 60 gr.

e. **Potassii Chloras.**—Potassium Chlorate. $KClO_3$.

Source.—Made by passing Chlorine gas into water containing Lime or Magnesia in suspension; treating the clarified liquid with Potassium Chloride; and crystallising.

Characters.—Colourless monoclinic crystals with a cool, saline taste. Explodes when rubbed with sulphur or sulphides. *Solubility.*—1 in 16 of cold, 1 in 3 of boiling water.

Dose.—5 to 15 gr.

Preparation.

Trochiscus Potassii Chloratis.—3 gr. with Rose Basis.

f. **Potassa Sulphurata.**—Sulphurated Potash. See *Sulphur*, page 136.

2. Potassii Tartras Acidus.—Acid Potassium Tartrate. $(CHOH)_2COOH{\cdot}COOK$. Purified Cream of Tartar.

Source.—Prepared from argol deposited in wine-casks during the fermentation of grape juice; and from the lees of wine.

Characters.—A white gritty powder, or fragments of crystalline cakes; of a pleasant acid taste not deliquescent

Solubility.—1 in 200 of cold water; not in alcohol. *Impurities.*—Other metals; sulphates and chlorides.

Dose.—20 to 60 gr. (as a diuretic and refrigerant; 2 to 8 dr. as a purgative).

Acid Potassium Tartrate is an ingredient of:

Confectio Sulphuris; Pulvis Jalapæ Compositus, and Trochiscus Sulphuris. *It is also used in preparing* Acidum Tartaricum, Ferrum Tartaratum, Antimonium Tartaratum, and Soda Tartarata.

From this salt is made:

Potassii Tartras.—Potassium Tartrate. $(CHOH_2)_2(COOK)_2,H_2O$.

Source.—Made by neutralising Acid Potassium Tartrate with Potassium Carbonate.

Characters.—Small, colourless, 4- or 6-sided prisms. *Solubility.*—1 in 1 of water; solution neutral. Insoluble in alcohol. *Impurities.*—Acid Tartrate, detected by comparative insolubility; metals. *Dose*, 30 to 60 gr. as a diuretic and antacid; 120 to 240 gr. as a purgative.

3. Potassii Nitras.—Potassium Nitrate. KNO_3. Nitre. Saltpetre.

Source.—Obtained native, chiefly in the surface soil of India, and purified by crystallisation from solution in water; or by interaction of $NaNO_3$ and KCl.

Characters.—Striated, 6-sided colourless prisms, of a cool saline taste. *Solubility.*—1 in 4 of cold, 2 in 1 of boiling water. *Impurities.*—Sulphates, Chlorides; and other metals. *Dose*, 5 to 20 gr.

From Potassii Nitras are made:

a. Argenti Nitras Induratus. See *Argentum*, page 71.

b. Argenti Nitras Mitigatus. See *Argentum*, page 71.

4. Potassii Sulphas. — Potassium Sulphate. K_2SO_4.

Source.—Native, or prepared by purifying the crude salt; or by the interaction of Sulphuric Acid and the Chloride or certain other salts of Potassium.

Characters.—Colourless, hard, rhombic prisms, terminated by six-sided pyramids. *Solubility.*—1 in 10 of cold, 1 in 4 of boiling water; insoluble in alcohol, 90 %. *Impuri-*

tues.—Nitrates, chlorides; and other metals. *Dose*, 10 to 40 gr.

Potassii Sulphas is contained in: Pulvis Ipecacuanhæ Compositus, 8 in 10; Pilula Colocynthidis Composita, 1 in 24; Pilula Colocynthidis et Hyoscyami, 1 in 32; and Pilula Ipecacuanhæ cum Scillâ, 1 in 2.

5. Potassii Bichromas.—Potassium Bichromate. K_2CrO_4,CrO_3.

Source.—Made by (1) roasting Chrome Ironstone (FeO,Cr_2O_3) with lime in presence of air; (2) treating the product with a potassium salt, by which Yellow Chromate of Potassium is obtained, K_2CrO_4; (3) subsequently with an acid, *e.g.* Sulphuric Acid, this yields Red or Potassium Bichromate.

Characters.—Large, orange-red, transparent triclinic crystals; soluble in 10 parts of cold water; anhydrous. Fuses below redness; at a higher temperature is decomposed, yielding green Chromium Oxide and Yellow Potassium Chromate, which may be separated by dissolving the latter in water. *Dose*, $\frac{1}{10}$ to $\frac{1}{5}$ gr. (in pill form).

Potassii Bichromas is used to make:

Acidum Chromicum. See page 152.

GENERAL CHEMICAL CHARACTERS OF POTASSIUM SALTS.

Aqueous solutions (1) acidulated with HCl give a yellow granular precipitate with $PtCl_4$; (2) give a white granular precipitate with $H_2C_4H_4O_6$; (3) impart a light violet or lavender tinge to flame; and (4) do not volatilise when heated.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Potassa Caustica is a powerful irritant and painful **caustic**, absorbing water from the affected part, and converting it into a moist, grey slough. It or Vienna Paste (*see* page 58), is used to destroy morbid growths, to form issues, and to stimulate ulcers. The Liquor and the Carbonates are also **antacid**: they neutralise caustic acids on the skin; hot dilute solutions relieve the pains of rheumatism and gout, when used as fomentations or local baths; and weak compounds of Potassium with Olive Oil, constituting Soft Soaps, have antacid and cleansing properties.

Internally.—The Liquor and Potassium salts with an alkaline reaction are employed as **antidotes** to caustic acids; but the use of the Carbonates for this purpose ought to be avoided, if possible, on account of the great development of carbonic acid which ensues. In the mouth, the alkali checks for a moment the secretion of saliva and impairs the appetite. Reaching the stomach just before meals, it is a **stomachic,** being a natural stimulant to the gastric glands (increasing the flow of the juice); and at the same time it is a sedative to the nerves. The Bicarbonate may be used for this purpose in dyspepsia, especially when there is much pain and tendency to sickness, or when the further action of Potassium on the system is desired, as in gouty, rheumatic and calculous subjects; but Sodium is more commonly employed. On the other hand, when given towards the end of gastric digestion, these alkalis are **antacid,** neutralising excessive or unnatural acidity of the contents, and dissolve mucus in acid dyspepsia. Large doses of the Bicarbonate irritate the stomach, and may cause sickness.

Some valuable **saline purgatives** belong to the Potassium group, notably the Acid Tartrate, Tartrate and Sulphate. The rationale of the action of saline purgatives is discussed in Part IV. (page 503.) In dropsy from any cause, especially ascites from hepatic disease, the Acid Tartrate, in Pulvis Jalapæ Compositus, in an electuary with honey, or in a lemonade (Imperial Drink) is used to remove water by the bowels, its evacuant effect as a **hydragogue** being assisted by its action as a diuretic. The vegetable salts of Potassium are partly converted into bicarbonate in the bowel.

2. ACTIONS ON THE BLOOD, AND USES.

Potassium is freely absorbed into the blood in the form of salts, and there acts (1) on the plasma, and (2) on the red corpuscles, increasing the natural alkalinity of the former, and improving the quality and increasing the number of the latter when judiciously combined with Iron.

(1) As an **alkaliniser** of the plasma Potassium is exceedingly transitory in its action, being very rapidly excreted; and the use of Potassium salts in gout is not supported by any reaction that can be discovered to occur between it and urates in the blood. The Bicarbonate, Citrate, Tartrates and Acetate were once employed in acute rheumatism.

(2) To restore the red corpuscles in anæmia by the increase of this element, Potassium is given as a **hæmatinic,** in Mistura Ferri Composita and in Ferrum Tartaratum.

An indirect action of Potassium on the blood must here

be carefully noted. We shall see hereafter that Citric, Tartaric, and Acetic Acids, given internally, are partially oxydised in the blood. The completeness of the combustion, and of the important influences which the change exerts on the blood and kidneys, depends upon the combination of the vegetable acid with an alkali. Citric acid *e.g.* is excreted partly unchanged in the urine, but Potassium Citrate entirely, or almost entirely, as the carbonate. (*See* page 149.)

3. SPECIFIC ACTIONS AND USES.

Potassium **depresses the muscular, nervous, and cardiac tissues**; and the point of interest in this connection is, that when given for other purposes it must be used with caution. The danger of "potash poisoning" is, however, exaggerated, for ordinary food contains abundance of Potassium salts, and the drug passes so quickly through the system that it does not produce a deleterious effect on the tissues unless given for a long time, or in disease of the excreting organs, especially the kidneys. Excessive single doses are generally vomited at once.

4. REMOTE LOCAL ACTIONS AND USES.

Potassium is excreted very rapidly. It escapes almost entirely by the kidneys, to a much less extent by the skin, respiratory passages, stomach, liver, biliary passages and bowels: in other words, in the fluids of all the secreting surfaces. In doing so it modifies the activity of the cells, and increases the alkalinity of some of the secretions, as follows:

1. *Kidneys.*—The **diuretic** effect of several Potassium salts, referable to their influence upon the renal epithelium, is the most important of all; and the Acetate, Acid Tartrate, Citrate and Tartrate, Carbonate, Bicarbonate and Sulphate are used for this purpose in the order named. The vegetable salts pass out as carbonates. These saline diuretics are given chiefly in renal dropsy, where it is desirable to increase the functional activity of the renal epithelium, and thus the secretion both of water and urea, whilst the vessels remain undisturbed. They are also suitable diuretics in feverish conditions. In cardiac dropsy they are less beneficial, as they diminish rather than increase the force of the circulation; but in an occasional full dose they are useful adjuvants, even in this condition, to other classes of diuretics, such as Digitalis and Scoparium, to wash out the tubules. Potassium Nitrate is a powerful diuretic, belonging partly to a different class, the local vascular stimulants. It is employed more

suitably as a diuretic in feverish conditions, and to remove inflammatory effusions into the pleura and pericardium, and should be given cautiously in renal disease.

The Bicarbonate and vegetable salts of Potassium are rapid and powerful **alkalinisers of the urine**; and are extensively used to produce this effect or reduce acidity in uric acid gravel and acute and chronic gout, the latter being preferred because less irritant. In uric acid calculus these salts are also employed, to prevent increase or return of the concretions. The waters of such spas as Baden-Baden, Wiesbaden, Vichy, Carlsbad and Aix-la-Chapelle, which contain definite though small quantities of Potassium salts, are in much repute for the treatment of acute and chronic gout and gravel.

2. *Skin.*—The **diaphoretic** effect of Potassium salts is not marked, the Citrate and Nitrate alone being used for this purpose, and these only in mild feverish attacks.

3. *Respiratory Passages.*—The bronchial secretions are increased and rendered less tenacious by Potassium Salts, which are thus **saline expectorants**, small doses of the Iodide being specially useful in dry catarrh of the tubes. If the dose of Potash be very large, the secretions are diminished and the mucosa is rendered anæmic.

4. *Alimentary Canal.*—*Gastric* catarrh, especially in gouty subjects, is benefited by the remote as well as the immediate local effect of the milder salts of Potassium; but the mineral waters that act partly in this way, such as those of Vals, Vichy and Carlsbad, owe their efficiency more to Sodium. The same remarks apply to catarrh of the *biliary* passages and tendency to gall stones.

The action of Potassium on the *intestinal glands* constitutes it a remote as well as an immediate purgative.

ACTIONS AND USES OF THE DIFFERENT SALTS OF POTASSIUM.

On reviewing what has been said respecting Potassium, we find that the chief actions and uses of its different salts may thus be briefly represented:—*Potassa Caustica:* caustic. *Liquor Potassæ:* stomachic and antacid. *Potassii Bicarbonas, Carbonas,* and *Citras:* antacid, stomachics, alkalinisers of the blood and urine, mild diuretics, very mild diaphoretics, saline expectorants, biliary stimulants. *Potassii Tartras, Tartras Acidus,* and *Acetas:* the same; but more powerful diuretics; also saline purgatives. *Potassii Sulphas:* chiefly purgative. *Potassii Nitras:* excreted unchanged in the

urine; diaphoretic, diuretic, and probably only in this way a mild febrifuge; used in fuming powders. The remaining salts of Potassium contain, in combination with the alkali, an element or acid possessing such distinctly specific actions that the total effect is but in a minor degree referable to the former. *Potassii Chloras:* excreted unchanged in all the secretions, including the saliva; much used in inflamed, ulcerated and aphthous states of the mouth; in large doses converts oxy- into met-hæmoglobin, and is thus a dangerous poison. The *Arsenite*, *Bromide*, *Iodide*, *Permanganate*, and *Sulphurated Potash* will be respectively discussed under the head of their other constituents.

SODIUM. Sodium. Na. 22·88.

There are four great sources of the official salts of Sodium and their preparations, viz. (1) Metallic Sodium, (2) the Chloride, (3) native Borax, and (4) the native Nitrate. They may therefore be arranged as follows:

1. Sodium.—The metal Sodium as met with in commerce.

Characters.—Soft, rapidly oxydising, showing a bright metallic surface when freshly cut. Decomposes water, and must be kept under naphtha.

From Sodium is prepared:

Liquor Sodii Ethylatis. *See* page 179.

2. Sodii Chloridum.—Sodium Chloride. NaCl Common Salt, purified.

Source.—Native.

Characters.—Small white crystalline grains, or transparent cubic crystals, free from moisture, with purely saline taste. *Solubility*, 1 in $2\frac{3}{4}$ of water.

Sodii Chloridum is used in making:

Acidum Hydrochloricum, Hydrargyri Perchloridum, and Hydrargyri Subchloridum.

From Sodii Chloridum are derived:

Sodii Carbonas.—Sodium Carbonate. Na_2CO_3, $10H_2O$.

Source.—Made from Sodium Chloride, by interaction with Ammonium Bicarbonate, and subsequent ignition. Or by (1) conversion into Sulphate, and (2 and 3) the action of heat on a mixture of the Sulphate with Carbon and Calcium Carbonate. (1) $2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl$. (2) $Na_2SO_4 + C_4 = Na_2S + 4CO$. (3) $Na_2S + CaCO_3 = Na_2CO_3 + CaS$.

Characters.—Transparent, colourless, laminar rhombic crystals, efflorescent; with a harsh taste, and strongly alkaline reaction. *Solubility.*—1 in 2 of cold water; insoluble in alcohol. 20 gr. neutralise 9·8 gr. Citric Acid, or 10·5 gr. Tartaric Acid. *Impurities.*—Sulphates and chlorides; other metals.

Dose.—5 to 30 gr.

Sodii Carbonas is used in preparing:

Extractum Ergotæ and Sodii Arsenas.

From Sodii Carbonas are made:

a. **Sodii Carbonas Exsiccatus.**—Exsiccated Sodium Carbonate, Na_2CO_3. A dry white powder, made from Sodium Carbonate by heating it until it loses about 63 per cent. of its weight.

Dose.—3 to 10 gr.

Sodii Carbonas Exsiccatus is used in making:

Pilula Ferri. (*See* page 82.)

b. **Sodii Bicarbonas.**—Sodium Bicarbonate. $NaHCO_3$.

Source.—Prepared by saturating the Carbonate with Carbonic anhydride. $Na_2CO_3 + H_2O + CO_2 = 2NaHCO_3$; or by interaction of Sodium Chloride and Ammonium Bicarbonate.

Characters.—A white powder, or small opaque monoclinic crystals, of a saline taste. *Solubility.*—1 in 11 of water. 20 gr. neutralise 16·7 gr. of Citric Acid, or 17·8 gr. of Tartaric Acid. *Impurities.*—Carbonate and its impurities.

Dose.—5 to 30 gr.

Preparation.

TROCHISCUS SODII BICARBONATIS.—**3 gr.,** with Rose Basis.

From Sodii Bicarbonas are made:

a. **Sodii Citro-tartras Effervescens.**—White

deliquescent granules. Made by heating the Bicarbonate with Citric and Tartaric Acids and Sugar; stirring until the powder assumes a granular form, sifting, and drying. Dose, 60 to 120 gr.

β. **Lithii Citras Effervescens.**—See page 54.

c. **Soda Tartarata.**—$(CHOH)_2COONa{\cdot}COOK,4H_2O$. Sodium Potassium Tartrate. Tartarated Soda. Rochelle Salt.

Source.—Prepared by neutralising Acid Potassium Tartrate with Sodium Carbonate. $Na_2CO_3+2(CHOH)_2COOH{\cdot}COOK = 2(CHOH)_2COONa{\cdot}COOK + H_2O + CO_2$.

Characters.—Colourless, transparent, trimetric prisms, tasting like common salt; neutral; entirely *soluble* in cold water. *Dose*, 120 to 240 grs. as a purgative; 30 to 60 gr. as a diuretic.

From Soda Tartarata is made:

Pulvis Sodæ Tartaratæ Effervescens.—"Seidlitz Powder." 120 gr., dried; Sodium Bicarbonate, dried, 40 gr.; in *blue* paper. Tartaric Acid, dried, 38 gr.; in *white* paper. *Dose*, the two powders, in nearly ½ pint of water, effervescing.

d. **Sodii Phosphas.**—Sodium Phosphate. $Na_2HPO_4, 12H_2O$.

Source.—Obtained by (2) adding a solution of Sodium Carbonate to a solution of Acid Calcium Phosphate prepared from (1) a mixture of Bone-ash and Sulphuric Acid. (1) $Ca_32PO_4 + 2H_2SO_4 = CaH_42PO_4 + 2CaSO_4$. (2) $CaH_42PO_4 + Na_2CO_3 = Na_2HPO_4 + H_2O + CO_2 + CaHPO_4$.

Characters.—Colourless, transparent, rhombic prisms, efflorescent, alkaline, tasting like common salt. *Solubility*, 1 in 6 of cold water. *Dose*, 30 to 120 gr. repeated; ¼ to ½ oz. at once.

From Sodii Phosphas is made:

Sodii Phosphas Effervescens.—A white granulated powder, made like Sodii Citro-tartras Effervescens, Sodium Phosphate being substituted for Sugar. *Dose*, 60 to 120 gr. repeated; ¼ to ½ oz. at once.

Sodii Phosphas is used to make Ferri Phosphas.

e. **Sodii Hypophosphis.**—See *Phosphorus*, page 107.

f. **Sodii Arsenas.**—See *Arsenium*, page 110.

g. **Sodii Benzoas.**—See *Benzoinum*, page 333.

h. **Sodii Sulphis.**—See *Acidum Sulphurosum*, page 151.

i. **Sodii Salicylas.**—See page 388.

j. **Sodæ Chlorinatæ Liquor.**—See *Chlorum*, page 124.

ii. Sodii Sulphas. — Sodium Sulphate. Na_2SO_4, $10H_2O$. Glauber's Salt.

Source.—Obtained by the interaction of Sodium Chloride and other Sodium salts with Sulphuric Acid.

Characters.—Colourless, transparent, monoclinic prisms, efflorescent, with a bitter saline taste. *Solubility.*—2 in less than 1 of water; insoluble in alcohol 90 %. *Dose.*—30 to 120 gr. repeated; ¼ to ½ oz. at once.

From Sodii Sulphas is made:

Sodii Sulphas Effervescens.—A white granulated powder, made like Sodii Citro-tartras Effervescens, with dried Sodium Sulphate instead of Sugar. *Dose.*—60 to 120 gr. repeated; ¼ to ½ oz. at once.

3. Borax.—Borax. Sodium Biborate. See *Acidum Boricum*, page 150.

4. Sodii Nitris.—Made from the native Nitrate. See *Acidum Nitrosum*, page 153.

5. Sodii Bromidum.—See *Bromum*, page 131.

6. Sodii Iodidum.—See *Iodum*, page 127.

7. Sodii Sulphocarbolas.—See *Acidum Carbolicum*, page 195.

GENERAL CHEMICAL CHARACTERS OF SODIUM SALTS.

Salts of Sodium (1) are characterised by their neutral solutions in water giving a precipitate with Potassium Metantimoniate. (2) They impart an intense yellow colour to flame. (3) They are not volatile.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—The Solution of Sodium Ethylate is used as a **caustic** to destroy small accessible tumours, such as nævi.

Solutions of the Carbonates may be employed to neutralise caustic acids; in eczema and itching disorders of the skin; and in extensive burns. Sodium compounds with Olive Oil constitute Hard Soaps.

Internally.—Sodium closely resembles Potassium in its action on the alimentary canal, but is more powerful because much more slowly absorbed. Thus the Bicarbonate stimulates the flow of the gastric juice, and is more commonly given as a **stomachic** than the other alkalis, in doses of gr. 8 to gr. 15, shortly before meals. Part of the salt at the same time becomes converted into the chloride, which assists the digestion of albumen. As the Bicarbonate, Soda Water, the official Lozenge, in mixture with Sal-volatile and an essential oil such as Peppermint, or as a natural alkaline water (Vichy, &c.), given between meals, it acts as an **antacid** to the contents of the stomach, relieving indigestion. The alkali also liquefies tenacious mucus, and enables the gastric juice to reach the food more freely. Weak solutions are used in lavage. Common Salt in large doses is a safe and available emetic.

The salts of Sodium, being much less diffusible than those of Potassium, pass on into the small intestine. Here the Sodium Sulphate and Phosphate and Tartarated Soda (Rochelle Salt) act as **saline purgatives**. The Sulphate, which is a constituent of several natural purgative waters, including Carlsbad, Marienbad, Friedrichshall and Hunyadi Janos, is the most powerful of these, producing an abundant watery evacuation. It is used as a hydragogue in dropsies, especially in ascites from hepatic disease; in congestion of the portal system; and as an ordinary purgative. The Phosphate is a milder but sufficiently active purgative, less unpleasant to the palate; it is often given to children. Soda Tartarata, the purgative basis of the Seidlitz Powder, is familiar as an intestinal stimulant, employed to complete the effect of purgative pills. The Chloride is anthelmintic when administered in enema.

2. Actions on the Blood, and Uses.

The salts of Sodium are slowly absorbed into the blood and slowly excreted from it, remaining in it chiefly as the Bicarbonate and Phosphate. Taken, as they constantly are, in food, these salts are the chief sources of the natural alkalinity of the liquor sanguinis, which may be increased by their medicinal exhibition as well as by the Citro-tartrate, Rochelle Salt and Sulphate. It would appear that this effect of Sodium as an **alkaliniser of the blood** cannot be turned to any therapeutical use directly; indeed that Sodium salts

diminish the solubility of Sodium biurate, the gouty poison in the plasma.

3. SPECIFIC ACTIONS.

In medicinal doses, the salts of Sodium have **no appreciably specific influence** on any particular organ. This circumstance is due to the facts that the whole organism is saturated with Sodium, which participates in many of the ordinary tissue-changes; that it is taken in large quantities in food (especially vegetables and fruits); and that the moderate amount contained in medicinal doses does not obviously affect metabolism. In this respect Sodium differs remarkably from Potassium, and it is said therefore to produce none of the depressing effects of that drug. As we have just seen, advantage is taken of this negative action of Sodium in its therapeutical applications. Natural mineral waters containing Sodium do, however, increase metabolism; and these are used successfully in gout, obesity and glycosuria.

4. REMOTE LOCAL ACTIONS AND USES.

Sodium is excreted by all the mucous surfaces, by the kidneys, by the liver, and possibly by the skin; and in passing through the various epithelial structures it modifies the amount, composition and reaction of their secretions. The actions of the different salts naturally differ to a considerable extent, some affecting one organ more, some another.

1. *Alimentary Canal.*—The Sulphate and the Phosphate of Sodium are, as we have seen, hydragogue purgatives by virtue of their *immediate* local action; but they are also stimulants of the intestinal glands, and are constantly being absorbed and excreted, re-absorbed and re-excreted, in their course along the bowel (*see* pages 500–501). Both salts, as well as the Bicarbonate, are also true **hepatic stimulants or direct cholagogues**; the Phosphate more so than the Sulphate. The value of these salts in hepatic and intestinal disorders, which has been already referred to, is therefore partly referable to their effect in increasing the bile. Soda Tartarata and Sodii Citro-tartras Effervescens have a similar but feebler action.

2. *Kidneys.*—Sodium acts as a **diuretic**, but less powerfully than Potassium, increasing the water and the solid constituents, including urea, and diminishing or neutralising the acidity of the urine. The Bicarbonate is the most useful salt of Sodium for this purpose; the Nitrate, whilst also diuretic, is inferior in this respect to the Potassium Nitrate, and very seldom employed. The Tartarated Soda may be usefully combined with other **alkalinisers of the urine**, as in the **Seidlitz Powder**; or the **Effervescing Citro-tartrate** may be

given. The uses of these alkalinisers of the urine are explained under Potassium.

3. *Respiratory Passages.*—The bronchial mucous membrane is said to become anæmic under the influence of large doses of Sodium salts, and its secretions to diminish; but if the dose be moderate, the sputa become more abundant and liquid, and are more easily expelled by cough. The Bicarbonate and Chloride are therefore indicated in the early stages of bronchitis, when the mucous membrane is hyperæmic and swollen, and cough harassing. The effects of Sodium on the stomach, blood and urine add much to its usefulness in such cases.

When a comprehensive view is taken of the actions and uses of the salts of Sodium (locally in the alimentary canal, in the blood, in the tissues, and in the organs and passages where it is excreted from the body), it is found to be peculiarly indicated in a condition of system which has been called "irregular" or "visceral gout," and "chronic derangements of the liver," and which is specially characterised, amongst other symptoms, by catarrhs from the mucous membranes; by disturbances of the functions of different organs, such as the heart and brain; by imperfect biliary activity and constipation; and by scanty, high-coloured, very acid urine, with occasional discharges of albumen and sugar. In such a condition great benefit may be derived from a course of *alkaline waters.* If the stomach be the principal seat of catarrh, *i.e.* if chronic indigestion be urgent, the more purely *carbonated alkaline waters* should be selected, such as those of Vichy, Bilin and Ems. If the derangement chiefly involve the liver and intestines, the *sulphated and salt* (NaCl) *waters* will be more suitable, such as Carlsbad, Kissingen, Wiesbaden and Marienbad. For chronic catarrh of the bladder and urinary passages, Ems, Vichy, Wildungen and Carlsbad are indicated.

5. ACTIONS AND USES OF THE DIFFERENT SODIUM SALTS.

The actions and uses of the preparations of Sodium may be summarised as follows, and the special actions of some of the salts particularly noticed: *Sodii Carbonas* and *Bicarbonas* (the former rarely, the latter almost invariably used) possess the actions and uses of Sodium in general upon all parts. *Soda Tartarata* is like the Carbonates, but purgative; and more rapidly and distinctly diuretic and alkalinising, by virtue of the Potassium it contains. *Sodii Citro-tartras* is like Tartarated Soda, but milder. *Sodii Sulphas* and *Sodii Phosphas*

are chiefly hydragogue purgatives and cholagogues, the former acting more on the bowels, the latter more on the liver. *Sodii Chloridum* is in large doses a free and safe emetic; an anthelmintic in enema. A ·9 per cent. solution in sterilised water is "normal saline." It is the most important constituent of the waters of Homburg, Wiesbaden, Nauheim, Kissingen and Baden-Baden, and of sea-water. The other salts of Sodium possess peculiar properties by virtue of their second constituent, and are described elsewhere: *Sodii Arsenas* under Arsenium; *Sodii Bromidum* under Bromum; *Sodæ Chlorinatæ Liquor* under Chlorum; *Sodii Hypophosphis* under Phosphorus; *Sodii Iodidum* under Iodum; *Boraæ* under Acidum Boricum; *Sodii Salicylas* under Salicinum; *Sodii Sulphis* under Acidum Sulphurosum; *Sodii Benzoas* under Benzoinum.

AMMONIUM. NH_4. 18.

All the official salts and preparations of Ammonium are derived directly or indirectly from the Chloride, that is, ultimately from Ammoniacal Gas Liquor.

Ammonii Chloridum.—Ammonium Chloride. NH_4Cl. Sal Ammoniac.

Source.—Made by neutralising Ammoniacal Gas Liquor with Hydrochloric Acid; evaporating to dryness; and purifying by sublimation. $NH_4HO + HCl = NH_4Cl + H_2O$.

Characters.—Colourless crystals; inodorous. *Solubility.*—1 in 3 of cold water; 1 in 60 of alcohol 90 per cent. Volatilises with heat. *Impurities.*—Iron, lead, and other metals; carbonates, nitrates, sulphates and thiocyanates.

Dose.—5 to 20 gr.

From Ammonii Chloridum are made:

1. **Liquor Ammoniæ Fortis.**—Strong Solution of Ammonia. NH_3, 32·5 per cent. by weight, dissolved in Water.

Source.—Made by heating Ammonium Chloride with Slaked Lime, and collecting the gaseous product in distilled water. $2NH_4Cl + Ca(HO)_2 = 2NH_3 + CaCl_2 + 2H_2O$.

Characters.—A colourless liquid with a very pungent characteristic odour, and strong alkaline reaction;

Sp. gr. 0·891. *Impurities.*—Ammonium chloride, sulphide, and sulphate; lime; other metals; tarry matters.

From Liquor Ammoniæ Fortis are made:

a. **Linimentum Camphoræ Ammoniatum.**—Ammoniated Liniment of Camphor. Strong Solution of Ammonia, 100; Camphor, 50; Oil of Lavender, 2·5; Alcohol 90 per cent. to make 400. 1 in 4.

b. **Spiritus Ammoniæ Aromaticus.**—Aromatic Spirit of Ammonia. Spirit of Sal Volatile. Strong Solution of Ammonia, 200; Ammonium Carbonate, 100; Oil of Nutmeg, 14·1; Oil of Lemon, 20·3; Alcohol 90 °/₀, 3000; Water, 1500. Distil the oils, alcohol and water; dissolve the Strong Solution of Ammonia and Ammonium Carbonate in a small part of the distillate with the aid of heat; and add the rest to make 3725. Sp. gr. ·888 to ·893. *Dose*, 20 to 40 min. repeated; 60 to 90 min. at once (well diluted).

c. **Spiritus Ammoniæ Fetidus.**—Fetid Spirit of Ammonia. Made by adding Strong Solution of Ammonia to a distillate of an extract made from Asafetida by maceration in alcohol 90°/₀. *Dose*, 20 to 40 min. repeated; 60 to 90 min. at once.

d. **Tinctura Guaiaci Ammoniata.**—See p. 263.

e. **Liquor Ammoniæ.**—Solution of Ammonia. NH_3 (10°/₀) dissolved in water. Strong Solution of Ammonia, 1; Distilled Water, 2. Sp. gr. 0·959.

Preparation.

Linimentum Ammoniæ.—Liniment of Ammonia. Solution of Ammonia, 1; Olive Oil, 2; Almond Oil, 1; shaken together.

From Liquor Ammoniæ are made:

α. **Ammonii Benzoas.**—Ammonium Benzoate. See *Benzoinum*, page 334.

β. **Ammonii Bromidum.** — Ammonium Bromide. See *Bromum*, page 131.

γ. **Ammonii Phosphas.** — Ammonium Phosphate. $(NH_4)_2HPO_4$.

Source.—Made by neutralising Phosphoric Acid with Solution of Ammonia.

Characters. — Transparent colourless prisms, becoming opaque by exposure. *Solubility.*—1 in 4 of cold water; insoluble in alcohol 90%. *Dose*, 5 to 20 gr.

Solution of Ammonia is also used in preparing Tinctura Opii Ammoniata, Tinctura Quininæ Ammoniata, and Tinctura Valerianæ Ammoniata.

2. Ammonii Carbonas.—Ammonium Carbonate.

Source.—Made by subliming a mixture of Ammonium Chloride (or Sulphate) and Calcium Carbonate. (1) $2NH_4Cl + CaCO_3 = (NH_4)_2CO_3 + CaCl_2$. (2) $2(NH_4)_2CO_3 = NH_4HCO_3 + NH_4NH_2CO_2 + NH_3 + H_2O$. (3) $NH_4HCO_3 + NH_4NH_2CO_2 = N_3H_{11}C_2O_5$. This salt is considered to be a compound of Ammonium Hydrogen Carbonate (NH_4HCO_3) with Ammonium Carbamate ($NH_4NH_2CO_2$).

Characters. — Translucent crystalline masses, efflorescent, volatile and pungent to the nose; alkaline. *Solubility*, 1 in 4 of cold water. 20 gr. neutralise $26\frac{3}{4}$ gr. Citric Acid, or $28\frac{3}{4}$ gr. Tartaric Acid. *Impurities.*—Sulphates and chlorides; tarry matters.

Dose.—3 to 10 gr. (as a stimulant or expectorant; 30 gr. as an emetic).

From Ammonii Carbonas are made:

a. Spiritus Ammoniæ Aromaticus. See page 49.

b. **Liquor Ammonii Acetatis.**—Solution of Ammonium Acetate. "Mindererus' Spirit."

Source.—Made by neutralising an aqueous solution of 50 of Ammonium Carbonate with sufficient Acetic Acid; and adding water to make 1000. NH_4HCO_3, $NH_4NH_2CO_2 + 3CH_3{\cdot}COOH = 3CH_3{\cdot}COONH_4 + H_2O + 2CO_2$. *Dose*, 2 to 6 fl.dr. Should be preserved in a green glass bottle.

c. **Liquor Ammonii Citratis.**—Solution of Ammonium Citrate.

Source. — Made by neutralising an aqueous solution of 125 of Citric Acid with 87·5 of Ammonium Carbonate; and adding water to make 1000. *Dose*, 2 to 6 fl.dr. Should be preserved in a green glass bottle.

GENERAL CHEMICAL CHARACTERS OF AMMONIUM SALTS.

Salts of Ammonium are soluble and colourless; and are easily decomposed and give up Ammonia on being mixed with a caustic alkali or lime.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Ammonia is a **stimulant** to nerves and other structures, causing a sensation of pain and burning, and reddening the part by dilating the vessels. If the application be prolonged and the vapour confined, blistering may result; but dilute preparations produce only a **rubefacient** effect and a sense of heat. It is used in the forms of Linimentum Ammoniæ and Linimentum Camphoræ Ammoniatum to stimulate the circulation in a part, either for the purpose of increasing the local nutrition, for instance, in stiffness or other chronic conditions of joints, or as a **counter-irritant** in diseases of deeper parts, *e.g.* on the surface of the chest in bronchitis. Liquor Ammoniæ is not to be used as a caustic; and vesication by it is better avoided. Ammonia is successfully applied to serpent's bite.

Internally.—Admitted into the *nose*, the vapour of Ammonia itself, or the Carbonate ("smelling salts"), is a powerful **general stimulant,** instantly causing a pungent sensation, watery secretion from the parts, including the conjunctiva, sneezing and other disturbances of respiration, and increased tension and frequency of the pulse. It is used accordingly as a means of resuscitating consciousness, the action of the heart, and respiration, in failure of the circulation such as fainting, and in asphyxia from any cause—drowning, hanging, or poisoning by narcotics. It arrests hiccup in some instances. The Chloride in the nascent (gaseous) form is inhaled for various affections of the nose and throat.

In the *stomach*, Ammonia produces the same effects as externally. A full dose (30 gr. of the Carbonate well diluted) is an emetic, which is best used in croup and bronchitis. Smaller doses cause a sense of warmth at the epigastrium, and act as **carminatives and reflex general stimulants** (*see* page 481), Sal Volatile chiefly being used for this purpose. In common with Sodium and Potassium, it has an **antacid** effect on the contents of the stomach, and is given after meals in dyspepsia. Like these, also, it acts as a natural stimulant to the gastric juice if given before meals; and Sal Volatile is a common ingredient of **alkaline stomachic**

mixtures. On the bowels, Ammonia in medicinal doses appears to have no immediate local action.

2. ACTIONS ON THE BLOOD, AND USES.

Ammonia is absorbed into the blood, and is there fixed; possibly increasing the alkalinity of the plasma of which it is a natural constituent, and diminishing the tendency to coagulation.

3. SPECIFIC ACTIONS AND USES.

Ammonia stimulates the central nervous system generally, especially the cord and the respiratory centre, whilst the force and frequency of the heart and the blood pressure are increased. It is thus a **general stimulant.** It is much given in exhausted states of the vital powers, especially if respiration and circulation threaten to fail, as in typhoid fever complicated with pneumonia; in the bronchitis of old or weakly subjects; and in ordinary acute pneumonia with increasing feebleness of the heart. For serpent's bite it is given internally in water, or hypodermically (10 to 20 minims diluted), whilst it is applied to the wound. The Chloride is a **direct cholagogue;** the Carbonate appears to increase the glycogen in the liver. Salts of Ammonium decidedly increase the production of urea; partly, at least, by their own decomposition with Carbonic Acid in the liver: (1) $2NH_3 + CO_2 = NH_4NH_2CO_2$ (Ammonium Carbamate). (2) $NH_4NH_2CO_2 = CO(NH_2)_2$ (Urea) + H_2O.

4. REMOTE LOCAL ACTIONS AND USES.

Ammonia is excreted by the kidneys as urea or uric acid, and possibly also as nitric acid. Thus, instead of diminishing, it maintains or actually **increases the acidity of the urine,** whilst the amount of urea and uric acid also rises, as well as the volume of secretion. The Chloride of Ammonium, although excreted partly unchanged, possesses these important powers most fully, the Acetate less fully; they may be employed as **diuretics** in dropsies and fevers.

The *bronchial* secretion is distinctly increased by the Carbonate and Chloride of Ammonium, and rendered more liquid and easily raised. These salts prove of great service as **expectorants** in the treatment of bronchitis when the secretion is scanty and thick, or the patient feeble; the accompanying stimulation of the respiratory centre increasing the vigour of cough and expectoration, whilst the heart also is strengthened.

The mucous secretion of the *stomach* is affected by Ammonia as by the other alkalis, and the Chloride may be used in chronic dyspepsia associated with bronchitis. Ammonia remotely stimulates the *intestines*, and causes diarrhœa if given in large doses.

On the *skin* Ammonium Acetate acts as a well-marked remote stimulant, Liquor Ammonii Acetatis being one of our most common **diaphoretics.** The Chloride also possesses the same property, but in a less degree.

5. Actions and Uses of the Different Salts of Ammonium.

These may be thus summarised: *Liquor Ammoniæ Fortis* and *Liquor Ammoniæ:* used as local and general stimulants, the former externally only. *Ammonii Carbonas:* volatile stimulant, emetic, and double expectorant (through the nerves and secretions). *Ammonii Chloridum:* local refrigerant, its solution producing cold; gastric, intestinal, and hepatic stimulant; nervous stimulant; diuretic, double expectorant, and diaphoretic. *Liquor Ammonii Acetatis:* diaphoretic and diuretic (febrifuge), and nervous stimulant. *Liquor Ammonii Citratis:* diuretic and diaphoretic. *Spiritus Ammoniæ Aromaticus:* agreeable and powerful carminative, antacid, and general stimulant. *Ammonii Phosphas:* direct cholagogue, possibly alkaliniser of the blood; nervine stimulant. *Spiritus Ammoniæ Fetidus:* see *Asafetida. Ammonii Benzoas:* see *Benzoinum. Ammonii Bromidum:* see *Bromum.*

LITHIUM. Lithium. Li. 6·97.

This metal is obtained from several minerals, such as Petalite and Lepidolite; and traces of it occur in certain mineral waters, *e.g.* **Baden-Baden,** Carlsbad, and Vals. Only two of its salts are official.

Lithii Carbonas.—Lithium Carbonate. Li_2CO_3.

Source.—Obtained from native silicates of Lithium.

Characters.—A white powder, or minute crystalline grains; alkaline. *Impurities.*—Many other metals; deficiency of Lithium, detected by weight of residue. *Solubility.*—1 in 70 of water; insoluble in alcohol 90 per cent.

Dose.—2 to 5 gr. (in 3 or 4 fl.oz. of aërated water)

From Lithii Carbonas is made:

Lithii Citras.—Lithium Citrate. $C_3H_4 \cdot OH \cdot (COOLi)_3 \cdot 4H_2O$.

Source.—Made by saturating Citric Acid with Lithium Carbonate.

Characters.—A white crystalline deliquescent salt. *Solubility*, 1 in 2 of cold water. *Dose*, 5 to 10 gr.

From Lithii Citras is made:

Lithii Citras Effervescens.—Made by heating Lithium Citrate with Citric and Tartaric Acids and Sodium Bicarbonate, stirring until the powder assumes a granular character, sifting, and drying. *Dose*, 60 to 120 gr.

GENERAL CHEMICAL CHARACTERS OF LITHIUM SALTS.

They impart a rich crimson colour to flame; and give a white precipitate with Na_2CO_3 after long standing. The Hydrate, Carbonate and Phosphate are only slightly soluble in water.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS.

Externally.—Salts of Lithium may be used in alkaline fomentations for gout.

Internally.—Salts of Lithium have doubtless an **antacid** action on the alimentary canal, very similar to that of Potassium. The Carbonate is apt to cause indigestion, but is given in very weak solutions.

2. ACTIONS ON THE BLOOD, AND USES.

Lithium quickly enters the blood, and is believed to **increase its alkalinity**, like Potassium.

3. SPECIFIC ACTIONS AND USES.

In this respect also Lithium closely resembles Potassium, being a cardiac and nervo-muscular **depressant** if given in large doses or for a length of time.

4. REMOTE LOCAL ACTIONS AND USES.

Lithium is rapidly excreted by the kidneys, and probably by the mucous membranes. It is a powerful **diuretic**, and **diminishes the acidity of the urine**, holding uric acid in solution as the biurate. It is a valuable remedy in gout, as it

hastens the excretion of urates. In uric acid gravel it might prevent accretion and fresh deposits in the kidneys and urinary passages.

Both salts of Lithium may be used, the main difference between them being as regards solubility, which is very marked.

CALCIUM. Calcium. Ca. 39·71.

There are three great sources of the official salts and preparations of Calcium, namely, (1) Chalk, (2) Native Sulphate, and (3) Bone-ash.

1. Creta Præparata.—Prepared Chalk. Native Calcium Carbonate freed from most of its impurities by elutriation.

Characters.—White friable masses or a white powder; *incompatible* with all acids and sulphates. *Impurities.*—Metals; phosphates, sulphates, silica. *Dose*, 10 to 60 gr.

Preparations.

α. **Mistura Cretæ.**—Chalk Mixture. Prepared Chalk, 5; Tragacanth, 7; Refined Sugar, 10; Cinnamon Water to make 160. *Dose*, ½ to 1 fl.oz.

β. **Pulvis Cretæ Aromaticus.** — Aromatic Powder of Chalk. Prepared Chalk, 11; Cinnamon, 4; Nutmeg, 3; Cloves, 1·5; Cardamom Seeds, 1; Sugar, 25. *Dose*, 10 to 60 gr.

From Pulvis Cretæ Aromaticus is made:

Pulvis Cretæ Aromaticus cum Opio. —Aromatic Powder of Chalk with Opium. Aromatic Powder of Chalk, 39; Opium, 1. *Dose*, 10 to 40 gr.

Creta Præparata is used to prepare:

Hydrargyrum cum Creta.—See *Hydrargyrum*, page 94.

From Creta Præparata are made:

a. **Calx.**—Lime. Calcium Oxide. CaO.

Source.—Obtained by calcining Chalk, Limestone, or Marble. $CaCO_3 = CaO + CO_2$.

Characters. — Compact whitish masses, which readily absorb water, swell, and fall to powder (slaking), with development of much heat.

From Calx is made:

Calcii Hydras.—Calcium Hydroxide. Slaked Lime. $Ca(HO)_2$.

Source.—Recently made by slaking Calcium Oxide with Water. $CaO + H_2O = Ca(HO)_2$.

Characters.—A white powder, strongly alkaline, more soluble in *cold* water (1 in 900), and with sugar (1 in 60). *Impurities.*—Many metals and other salts. *Incompatible* with vegetable and mineral acids, alkaline and metallic salts, and tartar emetic.

From Calcii Hydras are made:

i. **Liquor Calcis.** — Solution of Lime. Lime Water. Made by shaking up Calcium Hydroxide (previously washed in water to free it from chlorides) in Distilled Water, and decanting. ½ gr. of Lime in 1 fl.oz. *Dose*, 1 to 4 fl.oz.

Preparation.

LINIMENTUM CALCIS.—Solution of Lime and Olive Oil, equal parts, shaken together.

Liquor Calcis is also used in preparing:

Lotio Hydrargyri Flava, Lotio Hydrargyri Nigra, and Argenti Oxidum.

ii. **Liquor Calcis Saccharatus.**—Saccharated Solution of Lime. Made by digesting Calcium Hydroxide and Sugar in Water; and decanting. Contains 8 grains of Lime in 1 fl.oz. or 2 per cent. by weight of CaO. *Dose*, 20 to 60 min.

iii. **Calx Chlorinata.** — See *Chlorum*, page 123.

iv. **Calcii Hypophosphis.**—See *Phosphorus*, page 107.

b. **Calcii Chloridum.**—Calcium Chloride. $CaCl_2$, $2H_2O$.

Source.—Made by neutralising Hydrochloric Acid with Calcium Carbonate; and desiccating.

Characters.—White, very deliquescent masses, with bitter acrid taste. *Solubility.*—1 in 1 of water; 1 in 3 of alcohol 90 per cent. *Impurities.*—Carbonates; salts of aluminium and iron; hypochlorites, detected by evolving Cl with HCl. *Dose*, 5 to 15 gr.

Calcii Chloridum is used to make:

Calcii Carbonas Præcipitatus.—Precipitated Calcium Carbonate. Precipitated Chalk. $CaCO_3$.

Source.—Obtained by the interaction of Calcium Chloride and Sodium Carbonate. $CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$.

Characters. — A white micro-crystalline powder, insoluble in water. *Impurities.*—Phosphates, sulphates, aluminium, and iron. *Dose*, 10 to 60 gr.

From Calcii Carbonas Præcipitatus is prepared:

Syrupus Calcii Lactophosphatis.—Syrup of Calcium Lactophosphate. Made by dissolving 25 of Precipitated Calcium Carbonate in 60 of Lactic Acid, adding 46 of Concentrated Phosphoric Acid, triturating; and adding Orange-Flower Water undiluted, Sugar and Water. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

Calcii Carbonas Præcipitatus is contained in:

Trochiscus Bismuthi Compositus (4 gr. in each).

2. Calcium Sulphate.—Pure native Calcium Sulphate. $CaSO_4,2H_2O$. "Plaster of Paris."

Calcium Sulphate is used to make:

Calx Sulphurata.—See *Sulphur*, page 137.

3. Calcii Phosphas. — Calcium Phosphate. $Ca_3(PO_4)_2$.

Source.—Made by (1) dissolving Bone-ash in dilute Hydrochloric Acid; (2) adding dilute Solution of Ammonia; and washing and drying the precipitate. (1) $Ca_32PO_4 + 4HCl = CaH_42PO_4 + 2CaCl_2$; (2) $CaH_42PO_4 + 2CaCl_2 + 4NH_4HO = Ca_32PO_4 + 4NH_4Cl + 4H\,O$. Also by interaction of $CaCl_2$ and Na_2HPO_4.

Characters.—A light white amorphous powder, insoluble in water; soluble in diluted HCl or HNO_3. *Dose*, 5 to 15 gr.

Calcii Phosphas is contained in Pulvis Antimonialis, and in Extractum Euonymi Siccum.

GENERAL CHEMICAL CHARACTERS OF CALCIUM SALTS.

Calcium gives a red colour to flame. Solutions of Calcium salts give a white precipitate with Ammonium Oxalate, insoluble in Acetic Acid; not with Ammonium Sulphide.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Lime in the form of Calcium Oxide is **caustic,** like the alkalis, but its action is more localised, so that it may be combined with Caustic Potash to form a convenient preparation, *Potassa cum Calce*, Vienna Paste, for ordinary use. Dusted on the skin as Chalk, or applied as Lime-water, it is **astringent and desiccative** (drying), and is used to promote the healing of burns, eczema and ulcers. The Linimentum Calcis is valuable in burns and in some forms of extensive eczema.

Internally.—The local effect of lime is **antacid,** like that of the alkalis and magnesium, combined with an astringency peculiar to itself. In the mouth, Chalk is used as an antacid and physical dentifrice. Admitted into the stomach and intestines, as Lime-water or the Carbonate, Calcium (1) unites with the *free acids* of the contents. Lime-water prevents the gastric juice from curdling milk in large lumps, and is given extensively to artificially-reared infants, the Liquor Calcis Saccharatus being an excellent form when dilution of the food is undesirable. Lime is a valuable **antidote** in poisoning by the mineral acids and oxalic acid, and one which is available in the form of whiting; it must be freely given. Acid dyspepsia, with heart-burn, may be relieved with Lime-water or the Compound Bismuth Lozenge, given after food. (2) On the *glands* of the stomach the action of Calcium appears to be depressant; it is not suited for administration before meals. Lime-water is, indeed, a general **gastric sedative,** arresting some forms of vomiting, especially in the acid dyspepsia of infants and in pregnancy.

The Calcium salts can be traced along the whole length of the canal, and most of their bulk is finally expelled unabsorbed. Their **astringent** effect in diarrhœa may be in

part due to their control of acid fermentation; in part referable to an obscure sedative action on the intestinal glands (?and vessels), which diminishes the excretion of water in the bowel; in part physical. Lime and Chalk thus come to be two of our most valuable drugs in diarrhœa, either alone or with Aromatics, Opium, or vegetable astringents, as in the official preparations.

Lime-water is also employed locally as an enema for killing the thread-worm.

2. ACTIONS ON THE BLOOD, AND USES.

Calcium enters the circulation in very small quantities only, and appears in the plasma as a phosphate. It somewhat increases the alkalinity and coagulability of the blood.

3. SPECIFIC ACTIONS AND USES.

The important part played by Calcium as a constituent of bones has suggested its use as a specific remedy in rickets, fractures, and other lesions of these structures; and the Phosphate and Lime-water are extensively used for the two former conditions. The Phosphate and Chloride are recommended in scrofulous diseases of glands and phthisis, to promote absorption and possibly induce calcification; and calcareous waters may be of service in this respect. The Chloride is **hæmostatic**, and used in hæmophilia and hæmorrhages.

4. REMOTE LOCAL ACTIONS AND USES.

The greater part of Calcium being expelled by the bowel, little remains to be excreted by the kidneys. An alkalinising effect on the urine can scarcely be appreciated, but it is certainly **diuretic** in the form of the waters of Bath, Contrexéville, and Wildungen, which are valuable in gout, rheumatism and gravel.

5. ACTIONS AND USES OF THE DIFFERENT SALTS OF CALCIUM.

Creta in its various forms and combinations, *Calcii Carbonas Præcipitatus*, *Liquor Calcis*, and *Liquor Calcis Saccharatus:* possess the general actions and uses of Lime. *Calcii Chloridum:* recommended as a specific in scrofulous enlargement of glands; hæmostatic. *Calcii Phosphas:* specific in bone diseases and scrofula. *Calx Chlorinata* and its derivatives: media for supplying chlorine, and used accordingly (page 123). *Calcii Hypophosphis:* employed as a specific in tuberculosis and other wasting diseases (page 123). In the remaining preparations the action of the Calcium or

Chalk is comparatively insignificant, as in the three preparations of Mercury of which they are ingredients, and in Antimonial Powder. *Calcii Sulphas:* used for surgical and pharmaceutical purposes. *Calx Sulphurata:* used in suppuration, boils and scrofulous sores (page 137).

MAGNESIUM. MAGNESIUM. Mg. 24·18.

All the official salts and preparations of Magnesium are derived directly or indirectly from the Sulphate:

Magnesii Sulphas.—Magnesium Sulphate. $MgSO_4$, $7H_2O$. Epsom Salt.

Source.—Made from native Magnesium Carbonates, by interaction with Diluted Sulphuric Acid; or by purifying the native Sulphate.

Characters.—Small colourless rhombic prisms, with a bitter taste. *Solubility*, 1 in 1 of cold water. *Incompatible* with alkaline carbonates, lime-water, lead acetate, and silver nitrate. *Impurities.*—Other metals; nitrates. *Dose*, 30 to 120 gr. repeated; $\frac{1}{4}$ to $\frac{1}{2}$ oz. at once.

Preparation.

MISTURA SENNÆ COMPOSITA.—1 oz. in 4 fl.oz. See *Senna*, page 278.

From Magnesii Sulphas are made:

a. **Magnesii Sulphas Effervescens.**—Effervescent Epsom Salt.—A white granular powder. Made like Sodii Citro-tartras Effervescens (p. 42), with the addition of Magnesium Sulphate. *Dose*, 60 to 240 gr. repeated; $\frac{1}{2}$ to 1 oz. at once.

b. **Liquor Magnesii Carbonatis.**—"Fluid Magnesia." The Carbonate in solution.

Source.—Made by boiling together aqueous solutions of Magnesium Sulphate and Sodium Carbonate, and filtering the precipitate; diffusing it in water: and dissolving it in Carbonic Anhydride under pressure.

Characters.—A clear, slightly effervescing fluid. Nearly 10 gr. of Carbonate in 1 fl.oz. *Dose*, 1 to 2 fl.oz.

c. **Magnesii Carbonas Ponderosus.** Heavy Magnesium Carbonate. $3(MgCO_3)$, $Mg(HO)_2,4H_2O$.

Source.—Made by mixing *strong boiling* solutions of Magnesium Sulphate and Sodium Carbonate, evaporating, purifying, and drying. $4MgSO_4 + 4Na_2CO_3 + H_2O = 3(MgCO_3),Mg(HO)_2 + 4Na_2SO_4 + CO_2$.

Characters.—A white granular powder, comparatively insoluble in water. *Dose*, 5 to 30 gr. repeated; 30 to 60 gr. at once.

Magnesii Carbonas Ponderosus is contained in:

Trochiscus Bismuthi Compositus.—2 gr. in each. (*See* p. 119.)

From Magnesii Carbonas Ponderosus is made:

Magnesia Ponderosa. — Heavy Magnesia. Heavy Calcined Magnesia. MgO.

Source.—Made by exposing the Heavy Carbonate to a dull red heat.

Characters.—A white powder, insoluble in water. *Dose*, 5 to 30 gr. repeated; 30 to 60 gr. at once.

d. **Magnesii Carbonas Levis.**—Light Magnesium Carbonate. $3(MgCO_3)Mg(HO)_2 4H_2O$.

Source.—Made like Magnesii Carbonas Ponderosus, but with *cold dilute* solutions; boiling for 15 minutes; filtering, washing, and drying.

Characters.—A very light white powder, proving microscopically to be partly amorphous, with prismatic crystals. $3\frac{1}{2}$ times the bulk of the Heavy Carbonate. *Dose*, 5 to 30 gr. repeated; 30 to 60 gr. at once.

From Magnesii Carbonas Levis is made:

Magnesia Levis.—Light Magnesia. Light Calcined Magnesia. MgO.

Source.—Made by exposing Light Magnesium Carbonate to a dull red heat.

Characters.—A white, very light powder, $3\frac{1}{2}$ times the bulk of Heavy Magnesia; sparingly soluble in water. *Dose*, 5 to 30 gr. repeated; 30 to 60 gr. at once.

Magnesia Levis or Ponderosa is contained in Pulvis Rhei Compositus (6 parts in 9).

GENERAL CHEMICAL CHARACTERS OF MAGNESIUM SALTS.

The soluble salts of Magnesium give a white precipitate with Ammonia and Sodium Phosphate.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, the Silicate, French Chalk (not official), is used as a dusting powder.

Internally, Magnesium is a valuable means of decomposing the contents of the stomach and intestines:—

(1) The Oxide and Carbonates form comparatively insoluble or innocuous compounds with the mineral acids, oxalic acid, and mercuric, arsenical and cupric salts; in large quantities they prevent the absorption of alkaloids by rendering the contents of the stomach alkaline; the Sulphate precipitates insoluble sulphates of lead and barium. Magnesia or its salts may therefore be employed as **antidotes** in poisoning by these substances, the Oxide being preferred to the Carbonate to prevent the evolution of gas, and care being taken to give it very freely.

(2) By a similar process of decomposition, Magnesia neutralises normal or excessive acidity in the stomach and bowels, and is converted into the chloride, lactate and bicarbonate, this reaction removing irritant acid, and forming salts of Magnesium which have a purgative effect. The Carbonate yields carbonic acid, which exerts its specific action on the stomach. Either substance may be given between meals with Sodium Bicarbonate and Sal Volatile as an **antacid** in pyrosis, if a laxative effect also is desired.

The chloride, bicarbonate, or lactate formed in the stomach, and the Sulphate of Magnesium directly given, having reached the intestine, are absorbed very slowly; and if in sufficient quantity, produce marked effects as **saline purgatives**, the Sulphate being hydragogue in its action, with little direct stimulation of the muscular coat. The result is free evacuation of a quantity of water by the bowel, and with it almost the whole of the Magnesium. Magnesium Sulphate (Epsom Salt) is our most common saline purgative, in the form of Mistura Sennæ Composita; of a simple solution in Acid Infusion of Roses with a carminative; and of several popular aperient waters, such as Friedrichshall, Püllna and Hunyadi Janos, of which it is an important constituent. Magnesium Sulphate is a mild, painless, non-nauseating purgative, less rapid in its action than the Sodium salt. It

may be used to complete the effect of purgative pills in portal congestion; as an habitual laxative in chronic constipation, combined with other salts in the above-named waters; in dysentery, and in feverish attacks with loaded bowels. It may also be given in enema. Magnesia and the Carbonates are given as purgatives to children for diarrhœa with foul acid stools—very frequently as Pulvis Rhei Compositus (Gregory's Powder); and similar combinations are valuable in intestinal catarrh connected with portal congestion and gout.

In small doses neither salt is purgative, but enters the blood.

2. Actions on the Blood, and Uses.

Reaching the circulation as the chloride or lactate, Magnesium **increases the alkalinity of the plasma,** of which it is a normal constituent.

3. Specific Actions.

Magnesium Salts taken medicinally do not exert any appreciable effect upon the tissues or nutrition generally. Although important constituents of bone, they cannot be said to be of any value in rickets or other diseases in which the osseous tissue is deficient in solid matter.

4. Remote Local Actions and Uses.

When a Magnesium salt does not purge, it is excreted chiefly by the kidneys. It renders the urine more abundant, and this **diuretic** effect contributes to the value of Magnesium waters such as those of Harrogate, Ems, Baden-Baden, Aix-les-Bains, Carlsbad, etc., in gout and gravel; but they are ineffective as alkalinising agents.

BARIUM. Barium. Ba. 136·40.

This metal is introduced into the Appendix of the Pharmacopœia for testing purposes only, but may also be given medicinally.

Barium Chloride. $BaCl_2,2H_2O$.

Characters.—Colourless translucent tables. *Dose,* ½ to 2 gr.

Solution of Barium Chloride.—1 in 10 of Water.

GENERAL CHEMICAL CHARACTERS OF BARIUM SALTS.

Salts of Barium give an insoluble white precipitate with Sulphuric Acid or any soluble sulphate.

ACTIONS AND USES.

In the lower animals Barium salts greatly **disturb the blood pressure,** first increasing it, but greatly lowering it before death. The Chloride has accordingly been recommended in aneurysm. In animals, Barium also affects the central nervous system, and through it the muscles of the bowels, bladder, vessels and limbs, causing purgation, urination, spasms and convulsions ending in paralysis. The empirical use formerly made of the metal in chronic nervous diseases and in glandular enlargements may possibly be explained by these effects.

CERIUM. CERIUM. Ce. 139·20.

Only one salt of this metal is official.

Cerii Oxalas.—Cerium Oxalate. $Ce_2(C_2O_4)_3,9H_2O$.

Source.—Made by precipitating a solution of Ammonium Oxalate with a soluble Cerium salt.

Characters.—A white granular powder; insoluble in water. *Impurities.*—Other metals; other Oxalates (*e.g.* of lanthanum and didymium), the ash of which effervesces with boiling HCl. *Dose.*—2 to 10 gr.

ACTIONS AND USES.

Nothing is definitely known about the physiological action of Cerium. It has been given with benefit in **vomiting,** acid dyspepsia and heart-burn, especially when they occur in pregnancy.

GROUP II.

THE METALS.

The metallic elements officially recognised fall naturally into several Sub-Groups, according to their actions and uses: (1) Plumbum, Argentum, Zincum, Cuprum, and Aluminium; (2) Ferrum and Manganesium; (3) Hydrargyrum; (4) Phosphorus, Arsenium, Antimonium, and Bismuthum. Phosphorus is included here, although a non-metallic element, because it is very closely allied pharmacologically with Antimony and Arsenic.

Sub-Group 1.

Plumbum, Argentum, Zincum, Cuprum, Aluminium.

PLUMBUM. Lead. Pb. 205·35.

There are two official sources of the salts and preparations of Lead contained in the Pharmacopœia, namely: (1) the Oxide, and (2) the Carbonate.

1. Plumbi Oxidum.—Lead Oxide. PbO. Litharge.

Source.—Made by the action of air on melted Lead.

Characters.—Heavy scales of a pale yellowish-red colour. Soluble in diluted nitric acid and in acetic acid; insoluble in water. *Impurities.*—Copper, iron, and carbonates.

Preparation.

Emplastrum Plumbi.—Lead Plaster. Lead Soap. Oleate of Lead. 16 of Oxide boiled in 32 of Olive Oil and 16 of Water. $3PbO + 3H_2O + 2(C_3H_5 3C_{18}H_{33}O_2)$, (Glyceryl Oleate in Olive Oil)$=3(Pb2C_{18}H_{33}O_2)$, Lead Oleate $+ 2[C_3H_5(OH)_3]$, Glycerin.

Plumbi Oxidum or its Emplastrum is also contained in the following Emplastra: Hydrargyri, Plumbi Iodidi, Resinæ, and Saponis.

From Plumbi Oxidum is made :

Plumbi Acetas.—Lead Acetate. $Pb(C_2H_3O_2)_2,3H_2O$. "Sugar of Lead."

Source.—Made by dissolving Lead Oxide or Lead Carbonate in Acetic Acid. $PbO+2HC_2H_3O_2+2H_2O=Pb(C_2H_3O_2)_2, 3H_2O$.

Characters.— White spongy-looking masses of interlaced small white monoclinic prisms, slightly efflorescent, having an acetous odour and a sweet astringent taste. *Solubility.*—10 in 25 of cold water, yielding a slightly acid solution; 1 in 30 of alcohol, 90 per cent. *Incompatibles.*—Hard water, mineral acids and salts, vegetable acids, alkalis, lime-water, potassium iodide, all vegetable astringents, preparations of opium, albuminous liquids. *Impurities.*—Other metals, chlorides and nitrates. *Dose*, 1 to 5 gr.

Preparations.

a. PILULA PLUMBI CUM OPIO.—Lead Acetate, 18; Opium, 3; Syrup of Glucose, 2. About 1 of Opium in 8. *Dose*, 2 to 4 gr.

b. SUPPOSITORIA PLUMBI COMPOSITA.—Lead Acetate, 36; Opium, 12; Oil of Theobroma, 132; in 12 suppositories. 1 gr. of Opium in each.

c. UNGUENTUM PLUMBI ACETATIS.—1; with Paraffin Ointment, white, 24.

From Plumbi Acetas are made:

α. **Liquor Plumbi Subacetatis Fortis.**—Strong Solution of Lead Subacetate. Goulard's Extract. $Pb_2O(C_2H_3O_2)_2$, dissolved in water.

Source.—Made by boiling together Lead Acetate, 5; Lead Oxide, $3\frac{1}{2}$; and Water, 20; filtering, and adding water. $PbO+Pb2C_2H_3O_2=Pb_2O(C_2H_3O_2)_2$.

Characters.—A clear, colourless liquid, with sweet astringent taste and alkaline reaction. Sp. gr., 1·275.

Preparation.

LIQUOR PLUMBI SUBACETATIS DILUTUS.—Goulard's Lotion. Goulard Water. Strong Solution of Lead Subacetate, 1; Alcohol 90 per cent., 1; Water, 78.

β. Glycerinum Plumbi Subacetatis.

Source.—Made by boiling together Lead Acetate, 5; Lead Oxide, 3·5; Glycerin, 20; and Water, 12; filtering, and evaporating.

Preparation.

Unguentum Glycerini Plumbi Subacetatis.—1; with Paraffin Ointment, white, 5.

2. Plumbi Carbonas. — Lead Carbonate. Lead Hydroxycarbonate. $2(PbCO_3),Pb(OH)_2$. "White Lead."

Source.—Made by exposing Lead to the vapour of Acetic Acid, and at the same time to air loaded with Carbonic Anhydride from spent tan. $6Pb + 6HC_2H_3O_2 + 3O_2$ (air) + $2CO_2 = 2(PbCO_3),Pb(OH)_2 + 2H_2O + 3(Pb2C_2H_3O_2)$ (residual acetate, which again becomes oxydised, the process being continuous).

Characters.—A soft heavy white powder. *Solubility.*—Insoluble in water; entirely soluble in diluted Acetic Acid.

Preparation.

Unguentum Plumbi Carbonatis. — 1; with Paraffin Ointment, white, 9.

From Plumbi Acetas (or from Lead Nitrate) *is made:*

Plumbi Iodidum.—Lead Iodide. PbI_2.

Source. — Made by mixing solutions of Lead Acetate and Potassium Iodide; and washing and drying the precipitate.

Characters.—A heavy bright-yellow powder; tasteless; odourless. *Solubility.*—1 in 200 of boiling water, falling out as brilliant golden-yellow crystalline scales as the solution cools.

Preparations.

a. Emplastrum Plumbi Iodidi.—2; with Lead Plaster, 16, and Resin, 2.

b. Unguentum Plumbi Iodidi.—1; with Paraffin Ointment, yellow, 9.

GENERAL CHEMICAL CHARACTERS OF PLUMBIC SALTS.

Salts of Lead give a black precipitate with H_2S; a white precipitate with Alkaline Carbonates, and also with Diluted H_2SO_4; and a yellow precipitate with KI.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Lead salts act readily upon wounds, ulcers, and exposed mucous membranes. They (1) precipitate the albuminous fluids which cover their surface or flow from them as discharge; (2) coagulate the protoplasm of the young cells of the superficial layers; (3) *actively* contract the small arteries and veins of the part, thus diminishing or even arresting the circulation within them, and preventing the escape of the plasma and blood cells through their walls; and (4) probably also depress the nerves. These effects, as a whole, are called **astringent, antiphlogistic and sedative.** The Solutions of the Subacetate are much employed as applications to ulcers, and as injections for chronic inflammatory discharges from the vagina, urethra, ear, etc.; the Carbonate is dusted upon ulcers or used as Ointment. The Strong Solution of the Subacetate is a powerful irritant, causing pain and reaction, and is rarely used undiluted. The Unguentum Plumbi Iodidi may be rubbed into enlarged joints, glandular swellings and nodes, to produce its absorbent effect, which is chiefly referable to the Iodine. Applied in ointment, Lead certainly enters the circulation, probably in consequence of decomposition; and its specific effects presently to be described may arise in this way. Lead is said not to be absorbed by the unbroken skin; yet the Diluted Solution of the Subacetate is of unquestionable value in the treatment of contusions and superficial inflammations, probably from its astringent action on the blood-vessels. In the same form or as the Ointment it relieves itching.

Internally.—The local action of Lead is first appreciated in the mouth as a peculiar astringent taste, with a sharp sweetness in the case of the Acetate. On the mucous membrane of the throat it acts in the manner already described: coagulating the mucus, producing an astringent effect on the cells and vessels of the part, and causing a sensation of dryness. If inflammation be present it is rapidly controlled; and the Subacetate, either cautiously painted on as the strong Solution, or used as a gargle of the Diluted Solution, is an efficacious remedy for tonsillitis.

The local action of Lead continues in the stomach and intestine. It diminishes the secretions (including the bile), contracts the vessels, and arrests or retards the peristaltic movements; whilst it is itself converted into an albuminate by the fluids which it encounters. The Acetate is accordingly

given, with or without Morphine, to arrest hæmatemesis; and it is one of the most certain drugs in the treatment of obstinate diarrhœa, especially if ulceration be present and hæmorrhage threatening, as in typhoid fever, where it may be advantageously combined with Morphine or Opium.

2. ACTIONS IN THE BLOOD.

Lead quickly enters the blood as albuminate, but passes very rapidly through it, and cannot be found in it even after large doses. If Lead be given for some time, the blood becomes more watery, and the red corpuscles fewer in number.

3. SPECIFIC ACTIONS.

All the tissues take up Lead freely from the blood, and retain it obstinately as albuminate. The central nervous system is an important seat of its deposit, whilst it is even more abundant in the kidneys and liver as the channels of its escape, and in the bones from the sluggishness of their metabolism. Thus combined with the active cells of the body, Lead sets up a series of symptoms known as "plumbism." These are pathological, not physiological, effects, and may be briefly said to take the form of dyspepsia, constipation, and colic; anæmia and debility; a tense, infrequent pulse, with increased cardiac action; disturbances of the urinary flow; neuralgia; tremors, followed by paralysis, of the muscles, chiefly affecting the extensors of the wrist; and finally interstitial nephritis and general arterial sclerosis. Lead is an active ecbolic.

These symptoms and the results obtained by experiments on animals have been variously interpreted. Some authorities refer them to an irritant action of Lead on the involuntary muscular fibre of the stomach, bowels, and blood-vessels, similar to its astringent local effects, whence muscular contractions, painful spasms, narrowing of the vessels, and finally paralysis and other phenomena of exhaustion. Other pharmacologists contend that Lead acts primarily on the nerves and central nervous system, and only secondarily on the muscles, vessels, etc. Its effect in raising the blood pressure has been referred to irritation of the splanchnics, and consequent narrowing of the abdominal vessels; that is, to increased peripheral resistance. The increased blood pressure is the cause of the infrequent powerful cardiac action, and to some extent of the urinary disturbances.

4. SPECIFIC USES.

The specific actions of Lead are turned to important uses. It is a powerful **hæmostatic**, used in bleeding from the stomach and bowel, as we have said, and also from the lungs, Opium being advantageously combined with it to ensure mental and bodily rest, as the Compound Pill or Suppository, or as Lead Acetate, Morphine Acetate and Acetic Acid. Its value in diarrhœa is also partly referable to its specific action.

5. REMOTE LOCAL ACTIONS AND USES.

Lead is slowly excreted in the bile, urine, sweat and milk. In the bowel, the portion that has been excreted by the liver is reabsorbed, is again excreted, and finally escapes in the fæces as the sulphide. In passing through the kidneys, Lead diminishes the excretion of uric acid. It is used as a hæmostatic in renal hæmorrhage; more rarely in bronchorrhœa and in profuse sweating.

6. ACTIONS AND USES OF THE DIFFERENT SALTS OF LEAD.

The special action and uses of the different preparations of Lead are as follows:—The *Acetate* is the only salt given internally. The *Solutions of the Subacetate* are the only liquid preparations of the metal, and are used externally in lotions, injections, collyria, etc., as well as in the form of the Ointment. The *Oxide* is made into *Emplastrum Plumbi*, the basis of almost all plasters. The *Iodide* possesses, as already described, absorptive powers, by virtue of the Iodine, an effect which the Lead probably promotes. *Plumbi Carbonas*, in powder or as the Ointment, is applied to ulcers and inflamed surfaces for astringent purposes

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ARGENTUM. SILVER. Ag. 107·11.

Two salts of Silver are official, the Nitrate and the Oxide.

Argenti Nitras.—Silver Nitrate. $AgNO_3$. Lunar Caustic.

Source.—Prepared by the interaction of Silver and Nitric Acid. *Characters.* — Colourless, tabular, right rhombic prisms. *Solubility.*—2 in 1 of water; slightly soluble in alcohol 90 per cent.; soluble in ether and glycerin. *Incompatibles.*— Alkalis and their carbonates, chlorides, acids

(except nitric and acetic), potassium iodide, solutions of arsenic, and astringent infusions. *Impurities.*—Other metals; other nitrates, detected by evaporation of filtrate after precipitation with HCl. *Dose.*—$\frac{1}{4}$ to $\frac{1}{2}$ gr. (in pill, or with Diluted Nitric Acid).

From Argenti Nitras are made:

1. **Argenti Nitras Induratus.** — Toughened Caustic.

Source.—Prepared by fusing Silver Nitrate, 95, and Potassium Nitrate, 5; and pouring the mixed product into proper moulds.

Characters.—White or greyish-white cylindrical rods or cones; freely soluble in distilled water; only sparingly in alcohol 90 per cent.

2. **Argenti Nitras Mitigatus.** — Mitigated Caustic.

Source.—Prepared by fusing Silver Nitrate, 20, and Potassium Nitrate, 40; and pouring the mixed product into proper moulds.

Characters.—White or greyish-white cylindrical rods or cones; freely soluble in distilled water; sparingly in alcohol 90 per cent.

3. **Argenti Oxidum.**—Silver Oxide. Ag_2O.

Source.—Made by mixing solutions of Silver Nitrate and Calcium Hydroxide. $2AgNO_3 + Ca2HO = Ag_2O + Ca2NO_3 + H_2O$.

Characters.—A brown powder; slightly soluble in water. *Incompatible* with creosote, phenol, potassium permanganate, and many other substances, with which it forms explosive compounds. *Impurities.*—Metallic silver, evolving gas with nitric acid; nitrates; other metals. *Dose*, $\frac{1}{2}$ to 2 gr. in pill.

GENERAL CHEMICAL CHARACTERS OF ARGENTIC SALTS.

Salts of Silver give a black precipitate with H_2S; a white curdy precipitate with HCl, blackening on exposure to light.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—In the form of the solid pencil, Nitrate of Silver is a **caustic**, causing destruction with deep staining of the superficial layers, acute pain, inflammation of the deeper

layers, separation of the part as a slough, and then rapid healing. Unlike Caustic Potash, its effects are limited to the area of application. On this account it is the best caustic for ordinary use, and may be employed to destroy the affected part in bites of dogs and venomous animals, and in post-mortem wounds, or to remove small growths, especially lupus.

Solutions of the Nitrate, when applied to the broken skin or a mucous membrane, exert much the same action as Lead, but in a greater degree. Silver precipitates the albumens and the chlorides of the plasma or discharge; coagulates the protoplasm of the young cells; *actively* contracts the arteries and veins; and very rapidly coagulates the blood both within and without them. Silver Nitrate, or Mitigated Caustic, is the best of all local **antiphlogistics**, controlling the vascular disturbance, exudation and growth of the inflammatory process. It or Protargol, a soluble proteid compound (not official), is employed to touch callous and weak ulcers, including bed-sores; in diseases of the conjunctiva; and as an injection to inflamed surfaces, *e.g.* the urethra, vagina, os uteri and bladder. Solid caustic is a **hæmostatic** in bleeding from leech-bites. A weak solution in Spiritus Ætheris Nitrosi is used to harden the skin in threatening bed-sore.

Internally.—In the mouth, Silver meets with chlorides and albuminous fluids, combines with these, and acts on the surface of the mucous membrane as it does on the skin. The Nitrate is a useful remedy in inflammation of the tonsils and pharynx, whether applied in the solid form in acute cases, or in solution as an **astringent** in relaxed, chronic states.

Reaching the stomach, Silver Nitrate is decomposed by the hydrochloric acid and mucus, and cannot act as an irritant upon the mucous membrane unless given in poisonous doses. Its value in ulcer of the stomach must therefore be questioned. When properly given as a large enema ($\frac{1}{2}$ to 1 gr. to 1 fl. oz. of Distilled Water) for ulceration of the bowel, *e.g.* in chronic dysentery, it certainly possesses more action.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS AND USES, AND REMOTE LOCAL ACTIONS.

Silver slowly enters the blood as albuminate, or is absorbed as the pure metal by the lacteals, after the manner of fat. It has no obvious effect on the blood.

Silver becomes locked up, in the metallic form, in all the connective tissues of the body, and permanently stains exposed parts a dusky black-brown. It probably remains inert within the body; but some authorities believe that it affects

the nervous tissues, producing neuritis. The unsightly discoloration of the skin in argyria is a serious objection to its use.

Although Silver once admitted to the tissues is not excreted, a certain amount has been found in the urine; and a proportion passes through the bowels unabsorbed, appearing in the fæces as sulphide. It may cause nephritis.

ACTIONS AND USES OF THE DIFFERENT SALTS OF SILVER.

The *Nitrate* is almost invariably used both externally and internally; but the *Nitrate of Silver and Potassium* must be substituted in diseases of the eye. The *Oxide* is less irritant and is chiefly given internally, in the form of pill.

ZINCUM. Zinc. Zn. 64·91.

The primary source of the official salts and preparations of Zinc is the laminated or granulated metal.

1. **Zinci Chloridum.**—Zinc Chloride. $ZnCl_2$.

Source.—Produced by the interaction of Hydrochloric Acid and Zinc.

Characters.—Colourless opaque rods or tablets, very deliquescent, and caustic. *Solubility.*—Almost complete in water, alcohol 90 per cent., and ether.

Impurities.—Sulphates; other metals.

2. **Liquor Zinci Chloridi.**—Solution of Zinc Chloride.

Source.—Made by (1) dissolving Zinc in diluted Hydrochloric Acid, boiling, and cooling; then adding in succession (2) Chlorine Water, and (3) Zinc Carbonate, to precipitate iron or lead present as impurities; finally filtering, and evaporating to a fixed bulk. (1) $Zn_2 + 4HCl = 2ZnCl_2 + 2H_2$. (2) $2FeCl_2 + Cl_2 = Fe_2Cl_6$. (3) $Fe_2Cl_6 + 3ZnCO_3 + 3H_2O = Fe_26OH + 3ZnCl_2 + 3CO_2$. Also $PbCl_2 + Cl_2 + 2ZnCO_3 = PbO_2 + 2ZnCl_2 + 2CO_2$.

Characters.—Colourless, with sweetish astringent taste. Sp. gr. 1·530.

3. **Zinci Sulphas.**—Zinc Sulphate. $ZnSO_4, 7H_2O$.

Source.—Formed by the interaction of Zinc and Diluted Sulphuric Acid.

Characters.—Minute colourless prisms, with a strong metallic styptic taste. *Solubility.*—10 in 7 of water; insoluble in alcohol. *Impurities.*—Acetates, chlorides; other metals.

Dose.—1 to 3 gr. as a tonic; 10 to 30 gr. as an emetic.

From Zinci Sulphas are made :

a. **Zinci Carbonas.** — Zinc Carbonate. $ZnCO_3$, $(ZnH_2O_2)_2,H_2O$. Zinc Hydroxycarbonate.

Source.—Produced by the interaction of Zinc Sulphate and Sodium Carbonate. $3ZnSO_4 + 2H_2O + 3Na_2CO_3 = ZnCO_3(ZnH_2O_2)_2 + 2CO_2 + 3Na_2SO_4$.

Characters.—A white, tasteless, inodorous powder, insoluble in water. Entirely soluble in diluted Nitric Acid. *Impurities.*—Sulphates and chlorides; other metals.

From Zinci Carbonas are made :

a. **Zinci Oxidum.**—Zinc Oxide. ZnO.

Source.—Made by exposing the Carbonate to a dull red heat; or from Metallic Zinc by combustion.

Characters.—Prepared from the Carbonate, it is a soft, nearly white, tasteless and inodorous powder, becoming pale yellow when heated; prepared by combustion, it is white. Insoluble in water. *Impurities.*—Carbonates, chlorides, sulphates; other metals. *Dose*, 3 to 10 gr.

Preparation.

UNGUENTUM ZINCI. — Zinc Ointment. Zinc Oxide, 3; Benzoated Lard, 17.

From Zinci Oxidum is made :

Zinci Sulphocarbolas.—See *Acidum Carbolicum*, page 195.

β. **Zinci Acetas.**—Zinc Acetate. $Zn(C_2H_3O_2)_2$ $3H_2O$.

Source.—Made by neutralising Acetic Acid with Zinc Carbonate.

Characters. — Thin, translucent, colourless crystalline plates, of a pearly lustre; with sharp, unpleasant taste. *Solubility.*—10 in 25 of water. *Impurities.*—Those of the Carbonate. *Dose*, 1 to 2 gr.

γ. **Zinci Valerianas.**—Zinc Valerianate. See *Valerianæ Rhizoma*, page 325.

Zinci Carbonas is also used in making

Liquor Zinci Chloridi.

b. **Unguentum Zinci Oleatis.**—Prepared by precipitating Zinc Oleate by mixing aqueous Solutions of Zinc Sulphate and Hard Soap; washing; drying; and mixing with an equal weight of Soft Paraffin (white).

GENERAL CHEMICAL CHARACTERS OF ZINC SALTS.

Salts of Zinc give a white precipitate with $(NH_4)_2S$, insoluble in excess; a white precipitate with Solution of Ammonia, insoluble in excess.

Incompatibles of Zinc Salts in General.

Alkalis and their carbonates, lime-water, lead acetate, silver nitrate, astringent vegetable infusions or decoctions, and milk.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—The salts of Zinc closely resemble in their action the salts of Lead, Silver and Copper, being **caustic** in their stronger forms, **astringent or antiphlogistic** in their weaker forms. Zinc presents every degree of this action according to the salt employed, that is, probably according to the solubility and diffusion power of the particular combination of the metal. Thus the Chloride, which is highly deliquescent, penetrates the tissues and is a powerful escharotic, causing destruction of the part, with severe pain, separation of a slough, and subsequent healing. It is employed to destroy morbid growths, chronic ulcers and gangrenous parts, either as a paste or solid arrows made with plaster of Paris or flour, or as a strong solution. The Sulphate and Acetate have less affinity for water, and are much less powerful than the Chloride. When applied to the broken skin, an ulcer, or an exposed mucous surface, they precipitate the albuminous juices or secretions, coagulate the protoplasm of the upper layers of growing cells, and directly cause contraction of the vessels, though less than Silver and Lead. The Zinc Sulphate is the most common of this class of applications to healing ulcers and wounds, limiting the amount of discharge, checking excessive or "weak" growth, and modifying the intensity of the inflammatory process with which healing is associated. A solution of this salt is the basis of the "Red Lotion" of many hospital pharmacopœias; and other weak solutions of the same are

employed as a wash or injection for the eyes, urethra, vagina, and other accessible mucous tracts. The Oxide, Oleate and Carbonate act locally as mild astringents in inflamed conditions of the superficial layers of the skin such as eczema, controlling exudation and hyperæmia and protecting the parts from the air. Being insoluble in water, they are applied either as powder or ointment. The value of preparations of Zinc is referable in part to their **powerfully disinfectant** properties, a lotion of the Chloride (40 gr. to 1 fl.oz. of Water) preventing decomposition for several days.

Internally, the local action of Zinc corresponds. It is but little used in the mouth or throat, but its effect on the stomach as a local irritant furnishes us with the most familiar of our **direct emetics.** Zinc Sulphate, in doses of 20 grains, causes rapid and complete vomiting, attended with less immediate depression and less subsequent nausea than Antimony and Ipecacuanha. It is much employed in narcotic poisoning; more rarely in croup, diphtheria and phthisis, to clear the air-passages; and even to empty the stomach in acute dyspepsia. The Oxide on reaching the stomach is partly dissolved, and acts like the soluble salts of Zinc.

In the intestine the irritant action of Zinc is continued, if it be given in large doses, but this effect is never desired therapeutically. On the contrary, the Oxide, in sufficient doses to relieve a moderate superficial catarrh, is often a very efficacious **astringent** in the treatment of diarrhœa in children.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

Zinc enters the circulation very slowly, but nothing that can be turned to therapeutical account is known respecting its influence on the plasma or corpuscles.

The action of Zinc upon the tissues has been learned chiefly from its effect on workers in the metal. When it finds its way into the body for a length of time, it is a direct **depressant to the nervous centres**, especially the sensory parts of the spinal cord, and thus indirectly weakens and disturbs the muscular system. It has been employed with unquestionable success in epilepsy, chorea and whooping cough, all of which are characterised by nervo-muscular excitement.

3. REMOTE LOCAL ACTIONS AND USES.

The kidney, mammary gland, and probably the mucous surfaces and skin, are the channels of elimination of Zinc. It is possible that the metal exerts a second or **remote astrin-**

gent effect on these parts as it is leaving the system; for the Sulphate and Oxide appear to have the power of arresting chronic discharges from remote mucous passages, such as the uterus and vagina, even when given internally; and it is certain that the Oxide diminishes the perspirations of phthisis in some instances.

4. ACTIONS AND USES OF THE DIFFERENT SALTS OF ZINC.

These have been sufficiently indicated in the preceding description. The *Chloride* stands alone as a powerful escharotic, never to be given internally; it possesses also disinfectant properties as the *Liquor Zinci Chloridi*, which is used to mop out very foul wounds, and very extensively to wash infected rooms, flush drains, etc. (Burnett's disinfectant). The *Sulphate* and *Acetate* closely resemble each other in their action, but the Acetate is little used. The *Oxide*, *Carbonate* and *Oleate* are similarly allied, the first being most employed. *Zinci Valerianas* probably acts as a Zinc salt only, the Valerianic Acid appearing to be inert. See *Valerianæ Rhizoma*, page 324.

CUPRUM. Copper. Cu. 63·12.

The Sulphate is the only salt of Copper employed medicinally, although other compounds, as well as the metal itself, are introduced into the Pharmacopœia for chemical testing.

Cupri Sulphas.—Copper Sulphate. $CuSO_4,5H_2O$. Cupric Sulphate. "Blue Vitriol." "Bluestone."

Source.—Obtained by the interaction of Water, Sulphuric Acid and Copper or Cupric Oxide, evaporating, and crystallising. $4H_2SO_4 + Cu_2 = 2CuSO_4 + 2SO_2 + 4H_2O$.

Characters.—Blue triclinic prisms. *Solubility.*—1 in 3·5 of cold water, yielding a strongly acid solution; very soluble in glycerin; almost insoluble in alcohol 90 per cent. *Impurities.*—Other metals. *Incompatibles.*—Alkalis and their carbonates, lime-water, mineral salts (except sulphates), iodides, and most vegetable astringents. *Dose*, as an astringent, ¼ to 2 gr.; as an emetic, 5 to 10 gr.

GENERAL CHEMICAL CHARACTERS OF CUPRIC SALTS.

Copper Salts give a brownish-black precipitate with H_2S. Their solutions become deep blue with excess of NH_4HO; and deposit metallic Copper on a polished iron surface.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—The action of Copper differs but little from that of Silver and Zinc. It does not affect the unbroken skin, nor is it absorbed by it into the blood. Applied freely to wounds, ulcers or the delicate surface of exposed mucous membranes, such as the conjunctiva, the Sulphate ("Bluestone") is **caustic**; and is in frequent requisition to control exuberant granulations and touch granular lids, and for allied purposes. A swift and slight application of the crystal, or its solution in water, acts so far like Silver Nitrate: precipitating the discharges from a mucous or ulcerated surface; coagulating the superficial layers; thus contracting the blood-vessels and arresting discharge. It is used as a **stimulant** to ulcers; and a solution of 2 to 5 gr. to the fl.oz. may be used as an **astringent** lotion, or injected into the vagina, rectum, or urethra.

Internally.—If long administered, Copper may cause a greenish discoloration on the bases of the teeth (*not* of the gums), from direct combination with decomposing products there.

The Sulphate, in large doses (10 gr.), is not entirely converted into an albuminate in the stomach, but acts on the mucous membrane as an irritant and causes vomiting. It is a rapid **direct emetic**, and is suited for administration when the stomach is to be surely and speedily emptied of a narcotic poison like opium, or the air-passages are to be evacuated of mucus, as in bronchitis, if Ipecacuanha have failed. It causes less depression and subsequent nausea than Tartar Emetic. If Copper Sulphate fail to induce vomiting, the stomach must be evacuated by some other means, lest dangerous inflammation result.

Lastly, Copper Sulphate is a valuable antidote to Phosphorus, as it is reduced by the metalloid, the Copper being deposited upon the Phosphorus and rendering it inert. In cases of poisoning by Phosphorus, 3 gr. of Bluestone should be given in water every few minutes until vomiting occurs, followed by turpentine (page 403) and a saline purgative.

In the intestines Copper is an **astringent** in small

quantities; an irritant purgative in larger quantities. Small doses, combined usually with Opium, are given for some kinds of diarrhœa.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS AND USES, AND REMOTE LOCAL ACTIONS.

Given in small doses, Copper is very slowly absorbed into the blood; but we neither know any effect that it produces here, nor use it in this connection.

Its specific action on the tissues, in all of which it is found, is most difficult to evoke. It is said to weaken the voluntary muscles and heart, and to affect the nutrition of the central nervous system.

Copper is chiefly excreted by the liver, that is, leaves the body with the bile and fæces; part is discharged in the urine, and part by the saliva. Possibly it has some astringent action during its elimination.

ALUMINIUM. Al. 26·90.

Two salts of this metal are official.

1. **Alumen.**—Alum. Aluminium and Potassium Sulphate (Potassium Alum) $Al_2(SO_4)_3K_2SO_4,24H_2O$; or Aluminium and Ammonium Sulphate (Ammonium Alum) $Al_2(SO_4)_3(NH_4)_2SO_4,24H_2O$.

Source.—Produced by the combination of Aluminium Sulphate with Potassium Sulphate or with Ammonium Sulphate.

Characters.—Colourless transparent octahedra, with a sweetish, astringent taste. *Solubility.*—1 in 10 of cold, 9 in 3 of boiling, water; freely in glycerin; insoluble in alcohol 90 per cent. (solution acid). *Incompatible* with alkalis, lime, baryta, lead, tartrates, tannic acid, mercury, and iron. *Impurities.*—Other metals. *Dose*, 5 to 10 gr.

Preparation.

GLYCERINUM ALUMINIS. — 20, triturated with Distilled Water, 7·5, and Glycerin up to 120, with gentle heat.

From Alumen is made:

Alumen Exsiccatum.—Exsiccated Alum.

Source.—Made by heating *Potassium* Alum till aqueous vapours cease to be disengaged.

Characters.—A white powder. Has lost about 46 % of weight by heating. *Solubility.*—1 in 20 of cold, and 10 in 7·5 of boiling, water. It absorbs moisture when exposed to air.

2. **Kaolinum.**—Kaolin. A native Aluminium Silicate, powdered, and freed from gritty particles by elutriation.

Characters.—A soft whitish powder, insoluble in water or in diluted acids.

Kaolin is used to prepare: Pilula Phosphori.

GENERAL CHEMICAL CHARACTERS OF ALUMINIUM SALTS.

Salts of Aluminium give a gelatinous whitish precipitate with $(NH_4)_2S$, soluble in Liquor Potassæ.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Alum possesses the **astringent and styptic** effects fully discussed under *Plumbum*, page 68. In the form of powder, it arrests bleeding from the nose, gums and other accessible parts. Exsiccated Alum absorbs water, and is somewhat **caustic,** if the skin be broken, for instance over ulcers, destroying weak exuberant granulations. Solutions of Alum are used as injections in discharges from the rectum, vagina, uterus and urethra; as a collyrium it must be employed cautiously. Kaolin is used as a dusting powder.

Kaolin is also employed as a basis for pills or powders containing drugs readily decomposable by ordinary bases, *e.g.* Silver Nitrate, Potassium Permanganate and Phosphorus.

Internally.—The local action of Alum is appreciated in the mouth as an "astringent taste," and in the throat as "dryness," the mucous secretions of the parts being coagulated, and the membrane constringed, especially if it be inflamed and swollen. Alum is therefore used as a mouth wash in ulceration and tender gums; and in the form of gargles or sprays, combined with other substances, as a remedy for sore throat. A similar effect is produced in the stomach and intestines, dyspepsia and constipation being the result; in large doses Alum is **emetic** and purgative. A teaspoonful mixed with syrup is an excellent vomit in croup.

In doses of 30 gr., frequently repeated, it relieves lead colic by opening the bowels, and probably precipitating the soluble salts of lead.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS, AND REMOTE LOCAL ACTIONS AND USES.

Alum is absorbed into the blood, probably as an albuminate. It is believed to possess astringent properties in the tissues, arresting hæmorrhage and chronic discharges from the mucous membranes; and is used with doubtful benefit in hæmoptysis, epistaxis, gleet and diarrhœa. Aluminium chloride (not official) relieves the pains of tabes. Alum is excreted by the kidneys, and may arrest hæmaturia. Part of the salt possibly escapes by the skin, as it proves useful in some cases of excessive sweating.

Sub-Group 2.

FERRUM. Iron. Fe. 55·60.

All the official salts and preparations of Iron are made from the metal, directly or indirectly.

Ferrum. — Iron. Annealed Iron Wire, No. 35, or Wrought-iron Nails, free from oxide.

From Ferrum are made:

1. **Ferri Sulphas.**—Ferrous Sulphate. $FeSO_4,7H_2O$.

Source.—Prepared by the interaction of Diluted Sulphuric Acid and Iron.

Characters.—Pale bluish green, oblique rhombic prisms, with astringent taste. *Solubility.*—1 in 1½ of cold water; insoluble in alcohol 90%. *Impurities.*—Persalts; other metals. *Dose*, 1 to 5 gr.

From Ferri Sulphas are made:

a. Mistura Ferri Composita. Compound Mixture of Iron.—"Griffiths' Mixture." Ferrous Sulphate, 25; Potassium Carbonate, 30; Myrrh, 60; Sugar 60; Spirit of Nutmeg, 50; Rose Water, 4375. $FeSO_4 + K_2CO_3 = FeCO_3 + K_2SO_4$. A dark, green mixture. *Contains Iron Carbonate. Dose*, ½ to 1 fl.oz.

b. **Ferri Sulphas Exsiccatus.** Exsiccated Ferrous Sulphate.—$FeSO_4,H_2O$.

Source.—Made by heating the Sulphate to 212° F., thus removing 40 °/₀ of its weight; and powdering.

Characters.—A nearly white powder, slowly but entirely soluble in water. 2½ gr. = about 4 gr. of crystalline Sulphate. *Dose*, ½ to 3 gr.

Preparations.

a. PILULA ALOES ET FERRI.—1 in 9. See *Aloe Socotrina*, page 415.

β. PILULA FERRI. Iron Pill. "Blaud's Pill."—150; Exsiccated Sodium Carbonate, 95; Syrup, 150; Gum Acacia, 50; Tragacanth, 15; Glycerin, 10; Water, 20. About 1 gr. of Ferrous *Carbonate* in each pill. *Dose*, 5 to 15 gr.

c. **Ferri Carbonas Saccharatus.** Saccharated Iron Carbonate.—Ferrous Oxycarbonate, $xFeCO_3$, $yFe(OH)_2$, more or less oxydised, mixed with sugar; the ferrous salt, reckoned as Carbonate, $FeCO_3$, forming about one-third of the mixture.

Source.—Made by precipitating a solution of Ferrous Sulphate with a solution of Ammonium Carbonate; rubbing the washed precipitate with sugar; and drying. (1) $FeSO_4 + (NH_4)_2CO_3 = FeCO_3 + (NH_4)_2SO_4$. (2) $3FeCO_3 + O$ (from exposure) $= FeCO_3 + Fe_2O_3 + 2CO_2$. The sugar helps to prevent further oxydation.

Characters. — Brownish-grey lumps, with a sweet chalybeate taste. *Impurities.*—Sulphate; excess of Iron Oxide. *Dose*, 10 to 30 gr.

d. **Ferri Arsenas.**—Iron Arsenate. Ferrous Arsenate, $Fe_3(AsO_4)_2$, $6H_2O$, with Ferric Arsenate and some Iron Oxide.

Source.—Made by mixing hot solutions of Sodium Arsenate and Ferrous Sulphate, adding Sodium Bicarbonate; and washing and drying the precipitate. $3FeSO_4 + 2Na_2HAsO_4 + 2NaHCO_3 = Fe_3(AsO_4)_2 + 3Na_2SO_4 + 2H_2O + 2CO_2$.

Characters.—A greenish amorphous powder tasteless (but not to be tasted); insoluble in water readily soluble in HCl. *Impurities.*—Sulphates and general impurities. *Dose*, $\frac{1}{16}$ to ¼ gr. (in pill).

e. **Ferri Phosphas.**—Iron Phosphate. Hydrous Ferrous Phosphate, $Fe_3(PO_4)_2,8H_2O$, not less than 47 per cent., with Ferric Phosphate and some Oxide.

Source.—Made by mixing warm solutions of Sodium Phosphate and Ferrous Sulphate; adding Sodium Bicarbonate; and washing and drying the precipitate. $3FeSO_4 + 2Na_2HPO_4 + 2NaHCO_3 = Fe_3(PO_4)_2 + 3Na_2SO_4 + 2H_2O + 2CO_2$.

Characters.—A slate-blue amorphous powder; insoluble in water, soluble in HCl. *Impurity.*—Arsenium. *Dose,* 5 to 10 gr.

f. **Liquor Ferri Persulphatis.**—Solution of Ferric Sulphate.

Source.—Made from a hot solution of Ferrous Sulphate in Sulphuric Acid and Water, by boiling with Nitric Acid and Water. $6FeSO_4 + 3H_2SO_4 + 2HNO_3 = 3(Fe_23SO_4) + 4H_2O + 2NO$.

Characters.—A dark red, inodorous, very astringent solution, miscible with water and alcohol. Sp. gr. 1·441.

From Liquor Ferri Persulphatis are made:

a. **Ferri et Ammonii Citras.**—Iron and Ammonium Citrate.

Source.—Made by precipitating diluted Solution of Ammonia with diluted Solution of Ferric Sulphate and then dissolving the resulting Ferric Hydrate in a hot solution of Citric Acid; neutralising with Ammonia; evaporating, and drying in thin layers on porcelain or glass plates.

Characters.—Deep red, transparent scales, slightly sweet and astringent in taste. *Solubility.*—2 in 1 of water, giving a feebly acid solution; almost insoluble in alcohol 90 per cent. *Impurities.*—Tartrates; giving a crystalline precipitate with Acetic Acid; alkaline salts, detected in ash. *Dose,* 5 to 10 gr.

Preparation.

Vinum Ferri Citratis. — 18·3; Orange Wine, 1000. 8 gr. in 1 fl.oz. *Dose,* 1 to 4 fl.dr.

β. **Ferri et Quininæ Citras.**—Iron and Quinine Citrate.

Source.—Made like Ferri et Ammonii Citras, freshly precipitated Quinine being also dissolved in the Citric Acid solution.

Characters. — Greenish - golden yellow scales, somewhat deliquescent; bitter and chalybeate in taste. *Solubility.*—2 in 1 of water, the solution being very slightly acid. 1 of Quinine in 6·66. *Impurities.*—Alkaline salts, detected in the ash; other alkaloids instead of Quinine, insoluble in ether when precipitated by NH_4HO. *Dose*, 5 to 10 gr.

γ. **Ferrum Tartaratum.**—Tartarated Iron. *Source.*—Made like Ferri et Ammonii Citras, with Acid Potassium Tartrate instead of Citric Acid.

Characters.—Garnet scales, slightly sweetish and astringent. *Solubility.*—1 in 4 of water; sparingly in alcohol 90 per cent. *Impurities.*—Ammonia, evolved by boiling with solution of sodium hydroxide; ferrous salts. *Dose*, 5 to 10 gr.

δ. **Liquor Ferri Acetatis.** — Solution of Ferric Acetate.

Source.—Made by precipitating diluted Solution of Ferric Sulphate with diluted Solution of Ammonia; drying; dissolving the resulting Hydroxide in Glacial Acetic Acid; and diluting. (1) $Fe_23SO_4 + 6NH_4HO = Fe_26OH + 3(NH_4)_2SO_4$. (2) $Fe_26OH + 6HC_2H_3O_2 = Fe_26(C_2H_3O_2) + 6H_2O$.

Characters.—A red fluid, with a sour styptic taste and acetous odour; miscible with water and with alcohol 90 per cent. in all proportions. Sp. gr. 1·031. *Dose*, 5 to 15 min.

2. **Syrupus Ferri Phosphatis.**—1 gr. of Anhydrous Ferrous Phosphate, $Fe_3(PO_4)_2$, in 1 fl. dr.

Source.—Prepared by dissolving Iron (in wire) in Concentrated Phosphoric Acid and Water;

filtering into Syrup; and adding Water. *Dose*, ½ to 1 fl.dr.

3. **Syrupus Ferri Phosphatis cum Quinina et Strychnina.**—Syrup of Phosphate of Iron with Quinine and Strychnine.

Source.—Made by dissolving Iron (in wire), 8·6, in concentrated Phosphoric Acid, 62·5, and Water; and dissolving in the resulting solution Strychnine, 0·57, and Quinine Sulphate, 14·8; filtering into Syrup, 700; and adding Water to make 1000. 1 fl.dr. represents 1 gr. of anhydrous Ferrous Phosphate, ⅕ gr. of Quinine Sulphate, and $\frac{1}{32}$ gr. of Strychnine. *Dose*, ½ to 1 fl.dr.

4. **Liquor Ferri Perchloridi Fortis.**—Strong Solution of Ferric Chloride.

Source.—Made by (1) dissolving Iron (in wire) in Hydrochloric Acid and Water; (2) adding Hydrochloric Acid, and pouring into Nitric Acid; evaporating; and adding HCl and Water. (1) $Fe + 2HCl = FeCl_2 + H_2$. (2) $6FeCl_2 + 6HCl + 2HNO_3 = 3Fe_2Cl_6 + 4H_2O + 2NO$.

Characters.—An orange-brown liquid, with a strong styptic taste; miscible with water and alcohol in all proportions. Sp. gr. 1·42. 22·5 grains of Iron in 110 min. *Impurities.*—Ferrous salts; other metals.

Preparations.

a. Liquor Ferri Perchloridi.—Solution of Ferric Chloride. 1 of Strong Solution to 3 of Water. Sp. gr. 1·11. *Dose*, 5 to 15 min.

b. Tinctura Ferri Perchloridi.—Tincture of Ferric Chloride. 1 of Strong Solution to 1 of alcohol 90 per cent., and 2 of Water. *Dose*, 5 to 15 min.

From Liquor Ferri Perchloridi Fortis is made:

c. **Ferrum Redactum.**—Reduced Iron. Metallic Iron at least 75 per cent., with a variable amount of Oxide.

Source.—Made by reducing Ferric Hydroxide (obtained from a diluted solution of Ferric Chloride by precipitation with Ammonia), heated to dull redness, by a stream of dry hydrogen. $Fe_2O_2 2HO + 3H_2 = Fe_2 + 4H_2O$.

Characters.—A fine greyish-black powder, strongly attracted by the magnet. *Impurities.*—Excess of oxide, detected volumetrically; sulphides. *Dose*, 1 to 5 gr.

Preparation.

TROCHISCUS FERRI REDACTI.—1 gr. with the Simple Basis.

5. **Liquor Ferri Pernitratis.**—Solution of Ferric Nitrate, Fe_26NO_3.

Source.—Made by dissolving Iron Wire in Nitric Acid and Water. $Fe_2 + 8HNO_3 = Fe_26NO_3 + 4H_2O + 2NO$.

Characters.—A clear reddish-brown liquid, acid and astringent to the taste. Sp. gr. 1·107. 110 min. contain 3·3 gr. of Iron. *Impurities.*—Ferrous salts; other metals; chlorides and sulphates. *Dose*, 5 to 15 min.

6. **Vinum Ferri.**—Iron Wine. Iron (in wire) digested in Sherry for thirty days. 1 in 20. *Dose*, 1 to 4 fl.dr.

7. **Syrupus Ferri Iodidi.**—Syrup of Ferrous Iodide. Made by mixing with Syrup a hot solution of Iron (in wire) and Iodine in Water. Sp. gr. 1·380 to 1·387. 1 gr. of Ferrous Iodide in 11 min. *Dose*, 30 to 60 min.

GENERAL CHEMICAL CHARACTERS OF IRON SALTS.

Ferrous salts give with $(NH_4)_2S$ a black precipitate; with Potassium Ferrocyanide a precipitate at first white, afterwards blue; with Potassium Ferricyanide a dark blue precipitate. *Ferric salts* give a black precipitate with $(NH_4)_2S$; a blue with Potassium Ferrocyanide, a blue-black with a tincture of Galls.

Incompatibilities of Preparations of Iron in general.

Alkalis and their Carbonates, Lime Water, Calcium Carbonate, and Magnesia and its Carbonate give green precipitates with Ferrous Salts, brown with Ferric salts. Tannic and Gallic Acids give a deep blue-black with Ferric salts; and preparations of Iron, therefore, tinge Infusions of Chiretta and Hops, and change to brown or black those of Chamomile, Cusparia, Gentian, Orange, Cascarilla, Cloves, Digitalis, Cinchona, and all astringent infusions, but they can be given in Infusion of Quassia or of Calumba.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—A solution of a Ferric salt has a corrugating and **astringent** effect upon the broken skin and mucous surfaces: it coagulates the albuminous tissues, plasma and blood; and constringes or condenses the elements. The blood-vessels are thus closed or diminished in size, not actively as by Lead and Silver, but by compression from without; the circulation through them is diminished; hæmorrhage, if present, is arrested; and the abnormal escape of plasma and leucocytes, which characterises chronic inflammation or catarrh, is checked. Solutions of the Ferric salts are therefore used as **hæmostatics or styptics**, to arrest hæmorrhage from accessible parts, such as leech-bites, the nose and uterus; to cure nævi; less extensively in chronic discharges from the vagina, rectum and nose, as astringents. Injected into the rectum, they destroy worms. Iron is not absorbed by the unbroken skin.

Internally.—The constringent effect of Iron is appreciated in the *mouth* as a "styptic taste," whilst the teeth and tongue are blackened by the sulphide formed by decomposition. Beyond this, the local action corresponds with that just described externally. Various Iron solutions are usefully applied, either as gargles or with the brush, in some forms of chronic sore throat.

In the *stomach* all the salts of Iron, whatever their nature, are converted into the chloride, and partly combine with the acid albuminates like some other metals. If Iron be given in excess, or if the food or the hydrochloric acid of the gastric juice be deficient, the metal decomposes the whole of the digestive fluid, and acts upon the mucous membrane as an astringent and irritant. Iron is thus **unfavourable to digestion**; and in this connection we must carefully note: (1) that Iron may disorder the digestion even in healthy subjects; (2) that (with few exceptions) it must not be given in or after disease until the gastric functions so far have been restored; (3) that it is well to begin then with the mildest preparations; and (4) that it must be given after meals.—Dialysed Iron, in doses of 1 fl. oz., diluted with water, is an **antidote to Arsenic.** It should be preceded by a dose of common Salt or Sodium Bicarbonate, and given repeatedly.

In the *duodenum* Iron is converted into carbonate and hydroxide, and partly absorbed. The further effect of Iron on the bowel is a remote one, to be presently described. The

unabsorbed portion—by far the larger proportion—escapes as the Sulphide.

2. ACTION ON THE BLOOD, AND USES.

The action of Iron on the blood is almost unique of its kind: first, because its specific action is exerted, not upon the plasma, but upon the red corpuscle, and on this alone, not on any other tissue or organ; secondly, because this action appears to be nothing more than the combination of Iron as one of the constituent elements of the corpuscle with the others. In the case of no other metal can we speak so definitely of its *modus operandi.*

Iron enters the circulation as a highly complex compound with albumen. But absorption is now believed to occur not only very slowly but very sparingly: indeed, it is maintained that ordinary inorganic salts of Iron and their products in the stomach and bowels are unfit for absorption and are not absorbed at all. The unquestionable effect of Iron, medicinally given, in enriching the blood in hæmoglobin is said to be indirect only, and to consist in correction of alimentary disorders which interfere with the absorption of the Iron naturally present as a complex compound in ordinary food. Within the vessels it exists only as hæmoglobin. In healthy subjects a "course" of Iron increases the number and value of the red corpuscles; whilst in the anæmic the rapidity of these changes, as estimated day by day with the hæmacytometer and hæmoglobinometer, is remarkable. Iron accordingly is used as a **hæmatinic** in an endless variety of conditions in which hæmoglobin is deficient, such as simple anæmia, scrofula, amenorrhœa, cardiac disease, nephritis, syphilis, malarial cachexia, and convalescence from acute disease. The cautions already given respecting digestion must be faithfully respected, to secure its hæmatinic action over a length of time. Iron is a constituent of many well-known mineral waters, the most important being those of Spa, Tarasp, Kissingen, Kreuznach, Pyrmont and St. Moritz on the Continent; Tunbridge Wells, Harrogate and Strathpeffer in Britain; the Rawley Springs, Sweet Chalybeate and Bedford in the United States. Many blood-derivatives containing Iron (hæmatogen, hæmoglobin, etc.) are now used.

3. SPECIFIC ACTIONS AND USES.

Iron is stored in the liver cells, and there synthesised into various albuminous compounds. Its tonic effect appears to be entirely referable to its action on the red cor-

puscles. Abundance of oxygen is essential for every bodily and mental function; and the feeling of "tone," vigour, and mental fitness varies with the degree of oxygenation of the blood, *i.e.* with the quality of the blood as regards hæmoglobin. Nervous, muscular and cardiac debility are thus removed by Iron; and even digestion is restored by this gastric irritant, if it can be introduced successfully into the blood. The temperature is said to be slightly raised by Iron, showing increased oxydation. Fever is generally held to contra-indicate the use of Iron; and the same has been said of the use of it, except in mild forms or special combinations, in tuberculosis.

4. REMOTE LOCAL ACTIONS AND USES.

Iron is excreted by almost every channel. As it is absorbed, so a trace of it is excreted, along the whole length of the intestine, and colours the fæces black (sulphide). Only a small amount escapes in the urine (even if it be given hypodermically), saliva, sweat, milk, and pancreatic juice, and from the various mucous surfaces. Whilst passing out of the system, Iron produces a second or **remote astringent** effect. As regards the *bowels*, the clinical applications of this fact are most important. Thus most of the salts of Iron cause constipation unless combined with a purgative, such as Magnesium or Sodium Sulphates or Aloes; no good can be derived from Iron until the bowels have been thoroughly relieved, and are acting regularly; and certain salts, such as the Perchloride and Pernitrate, which are more astringent to the intestines than others, have been employed to check chronic diarrhœa and dysentery. This remote astringent action of Iron is the greater from the fact that it is also excreted by the liver, and passes down with the bile. Escaping very sparingly by other channels, Iron has been given in full doses when we d sire its action upon them, but probably is of very little if any use in these directions. In the *kidneys* it is excreted by the cells, not by the glomeruli; the urine falls somewhat in volume, but urea and other solids and the acidity are increased. It is doubtful whether hæmaturia be arrested by Iron. Iron similarly reduces the secretion of *milk* in nursing women. The remote effect of Iron on *mucous surfaces* was once believed to account for its value as a hæmostatic in recurrent passive bleedings from the nose, uterus, and respiratory passages, and as a remote astringent in chronic discharges from the same and allied parts, especially leucorrhœa. More probably in all these instances its hæmatinic action is the really useful one.

5. Actions and Uses of the Different Preparations of Iron.

Large as is the number of the preparations of Iron, they and their special actions may be easily remembered if grouped as follows:—

1. **Iron, its Oxides and Carbonates.**—This group comprises Ferrum Redactum, Vinum Ferri, Ferri Carbonas Saccharatus, Pilula Ferri and Mistura Ferri Composita. These preparations possess the hæmatinic action of Iron with but little astringency, and are accordingly selected to restore the blood when the patient has indigestion and constipation. They are the principal forms of Iron used in the routine treatment of anæmia, amenorrhœa and chlorosis in young women. These solid preparations form soluble compounds in the stomach as readily as do the fluid preparations belonging to the next group. The Mistura Ferri Composita and Pilula Ferri, although preparations of Ferrous sulphate, contain the Carbonate, and are favourite and valuable preparations for anæmia with amenorrhœa; the Iron acts as a hæmatinic, the Potassium also builds up the red corpuscle (the salts of which are almost entirely Potassium compounds), and the Myrrh increases the production of leucocytes as well as stimulating the uterus. Ferrum Redactum and the Saccharated Carbonate, although bulky powders, are easily taken and well borne. Vinum Ferri is an agreeable preparation largely prescribed for children.

2. **Compounds of Iron with the Mineral Acids.**—Ferri Sulphas in its various forms, Liquor Ferri Perchloridi and its preparations, and Liquor Ferri Pernitratis, are comprised in this group, which are characterised by their corrugating and astringent action. They are chosen, therefore, in all the external and internal applications of Iron for local purposes, especially as hæmostatics. The Strong Solution of the Perchloride is injected into the uterus in *post-partum* hæmorrhage in the form of a watery solution (1 part to 3) with the best results. Cotton wool or lint soaked in the same solution is used for plugging deep wounds, the cavities of the nose, mouth, etc., in hæmorrhage; but the action of the Iron on the surfaces of wounds, and the extensive coagulation which it sets up in the veins, are both objections to its employment, unless bleeding cannot be arrested otherwise. Internally these astringent preparations might be tried in hæmorrhage from the stomach or bowels, kidneys or bladder; but not, as a rule, in hæmoptysis. As hæmatinics, the Tincture or Liquor of the Perchloride, and the Pernitrate, well diluted, are much given to convalescents after the appetite has been restored,

and to persons who require a tonic; in passive hæmorrhages and chronic inflammatory discharges, such as leucorrhœa; and as a doubtful specific in erysipelas. In ordering this class of Iron salts, we carefully observe the various precautions already mentioned in connection with digestion. Proto-sulphate is well borne in the form of pill, and is a rapid hæmatinic.

3. **Compounds of Iron with Vegetable Acids.**—These are the Ferri et Ammonii Citras, Ferrum Tartaratum, and the Liquor Ferri Acetatis. They are at once the weakest, the blandest, and the least constipating preparations of Iron; and therefore are employed when only small quantities of the metal have to be given over a length of time as a tonic, or to commence a course of hæmatinics when the alimentary canal cannot tolerate the stronger preparations. They make little impression upon more severe forms of anæmia. They can be given with alkalis.

4. **Compounds of Iron with other Active Bodies.**—Iron is combined in the Pharmacopœia with Iodine—Ferri Iodidum; with Arsenic Acid—Ferri Arsenas; with Phosphoric Acid—Ferri Phosphas; and with Quinine—Ferri et Quininæ Citras. Speaking generally, it may be said that in these preparations the Iron is intended to relieve anæmia, or to act as a tonic in the sense we have described, whilst the other constituent specifically influences the diseased condition on which the anæmia or debility depends. Thus Ferrous Iodide is employed in syphilis and scrofula; the Arsenate in chronic diseases of the skin, liver, etc., with a gouty, rheumatic or malarial taint; the Phosphate in diseases of the bones, such as rickets; the compound with Quinine in malarial cachexia, where it may rapidly restore the blood corpuscles. But all the preparations of this group, especially the last, are also used as ordinary tonics, according to circumstances. The Solution of the Ferric sulphate is introduced solely as a source of several other preparations. Various non-official preparations are designed for hypodermic use.

MANGANESIUM. Manganese. Mn. 54·52.

Potassium Permanganate is the only drug to be discussed under this head.

Potassii Permanganas. — Potassium Permanganate. $K_2Mn_2O_8$.

Source.—May be obtained by the interaction of Potassium Chlorate, Potassium Hydroxide and Manganese Dioxide. (1) $3MnO_2 + KClO_3 + 6KHO = 3K_2MnO_4 + KCl + 3H_2O$; a manganate being formed. (2) $3K_2MnO_4 + 2H_2O = K_2Mn_2O_8 + {}_4KHO + MnO_2$; the manganate becoming permanganate by boiling.

Characters. — Dark purple slender iridescent prisms, inodorous, with a sweet astringent taste, yielding a rich purple solution when moistened. *Solubility.* —1 in 20 of cold water. Neutral. *Impurities.*—Dioxide, detected by being less soluble in water and by volumetric test; other metals; carbonates, chlorides, sulphates. *Dose*, 1 to 3 gr.

Preparation.

LIQUOR POTASSII PERMANGANATIS.—1 dissolved in 100 of Distilled Water. *Dose*, 2 to 4 fl.dr.

GENERAL CHEMICAL CHARACTERS OF MANGANESE SALTS.

Manganese salts give a flesh-coloured precipitate with $(NH_4)_2S$; a white with NH_4HO, partly soluble in excess.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Potassium Permanganate is an irritant or even caustic in the pure state; it is a stimulant in the form of the Solution, and promotes the healing of ulcers and wounds. Its principal applications, however, are independent of its physiological actions on the human tissues, and due to its influence as an **antiseptic, disinfectant and deodorant** on the causes, processes and products of sepsis and decomposition. By giving up oxygen freely, the Permanganate either destroys the ferments or organisms on which these processes depend, or forms chemical compounds, incapable of decomposition, with the materials on which they flourish —the tissues, plasma, pus, etc.: it is thus an *antiseptic.* By similarly oxydising the products of decomposition already begun, it so alters their chemical properties as to deodorise and decolorise them; and it also destroys the power of further infection which such products generally possess: it is thus a *disinfectant.* Potassium Permanganate therefore might be used as a dressing for foul ulcers; 1 in 150 is the strength required to destroy bacteria or prevent their reproduction. An immediate local injection of a 1 per cent. solution is an **antidote in snake-bite.**

Internally.—This salt is employed as a mouth-wash in foul conditions of the teeth and mouth, as a gargle in putrid sore-throat, and as an injection in infective and foul discharges, such as gonorrhœa, vaginitis, ozæna and cancer of the uterus. It is an **antidote** in poisoning by morphine and phosphorus.

2. Actions in the blood, specific actions, and remote local actions.

Nothing is definitely known of the actions of Permanganic Acid on the blood, tissues or organs of excretion. It is difficult to believe that any portion of the salt escapes decomposition before absorption, unless it be given in poisonous doses; and if given subcutaneously Manganese is excreted by the intestine. Manganese dioxide, into which the Permanganate is converted, does not combine with the hæmoglobin, and is believed to be inert, although once given as a hæmatinic. The internal administration of the Potassium salt for some supposed effect on infective fevers or gangrenous processes must therefore be useless. It has been prescribed as an emmenagogue.

By far the most important application of Potassium Permanganate is in solution as a disinfectant and deodorant apart from the human body: to cleanse the hands after contact with infectious cases; to disinfect stools and foul discharges after removal from the patient; to wash utensils; and to flush water-closets, etc. Its great advantages are that it is rapid and complete in its action, odourless, and non-poisonous in solutions of ordinary strength; and that it shows by change of colour whether it is acting or exhausted. The principal disadvantage connected with it is its expense.

Sub-Group 3.

HYDRARGYRUM. Mercury. Hg. 198·80.

Mercury is a drug of the first therapeutical importance. A large number of salts and other preparations of it are in use, which will be conveniently discussed in the following order: 1. the Metal itself; 2. Red Mercuric Oxide; 3. Mercurous Chloride; and 4. Mercuric Chloride.

1. Hydrargyrum.—Mercury. Hg.

Source.—Obtained from Cinnabar, native Mercuric Sulphide.

Characters.—Silver-white, liquid at ordinary temperatures; easily divisible into spherical globules. Boils at 662° F., and solidifies at −40° F.

Preparations containing free Mercury.

a. **Hydrargyrum cum Creta.**—Mercury with Chalk. Grey Powder. 1 in 3, with Prepared Chalk. *Dose*, 1 to 5 gr.

b. **Emplastrum Hydrargyri.**—Mercurial Plaster. 1 in 3, with Olive Oil, Sublimed Sulphur and Lead Plaster.

c. **Emplastrum Ammoniaci cum Hydrargyro.**—1 in 5. See *Ammoniacum*, page 304.

d. **Pilula Hydrargyri.**—Mercury Pill. "Blue Pill." 1 in 3, with Confection of Roses, 1½; and Liquorice Root, ½. *Dose*, 4 to 8 gr.

e. **Unguentum Hydrargyri.**—Mercury Ointment. 1 in 2 nearly, with Lard and Prepared Suet.

From Unguentum Hydrargyri are prepared:

α. LINIMENTUM HYDRARGYRI. — 3; with Strong Solution of Ammonia, 1; and Camphor Liniment to make 4·5. 1 of Mercury in 6.

β. UNGUENTUM HYDRARGYRI COMPOSITUM. —Compound Mercury Ointment. "Scott's Dressing." 10; with Yellow Beeswax, 6; Olive Oil, 6; and Camphor. 3·1 of Mercury in 5 nearly.

f. **Liquor Hydrargyri Nitratis Acidus.**—Acid Solution of Mercuric Nitrate. Mercuric Nitrate, $Hg2NO_3$, in solution in Nitric Acid.

Source.—Made by dissolving 24 of Mercury in 30 of Nitric Acid and 9 of Water, and boiling.

Characters.—A colourless, strongly acid liquid; sp. gr. about 2·0. *Impurity.*—Mercurous Nitrate, giving precipitate when dropped into diluted Hydrochloric Acid.

g. **Unguentum Hydrargyri Nitratis.**—Mercuric Nitrate Ointment. "Citrine Ointment." Made by adding a cold Solution of 4 of Mercury in 12 of Nitric

Acid, to 16 of Lard melted in 28 of Olive Oil; heating until the mixture froths up; and stirring till cold.

Preparation.

Unguentum Hydrargyri Nitratis Dilutum.—Diluted Mercuric Nitrate Ointment. 1 in 4, with Soft Paraffin, yellow.

2. Hydrargyri Oxidum Rubrum.—Red Mercuric Oxide. HgO. "Red Precipitate."

Source.—Made by heating Mercurous Nitrate (made from Mercury and diluted Nitric Acid) until acid vapours cease to be evolved.

Characters.—Orange-red crystalline scales or powder, nearly insoluble in water. Evolves O gas when heated, Hg remaining behind. *Impurities.*—Red lead and brick-dust, detected by being non-volatile; nitrates, detected by yielding nitrous vapours by heat. *Dose*, $\frac{1}{4}$ gr. to 1 gr.

Preparation.

Unguentum Hydrargyri Oxidi Rubri.—Red Mercuric Oxide Ointment. Red Precipitate Ointment. 1 in 10, with Paraffin Ointment, yellow.

3. Hydrargyri Subchloridum. — Mercurous Chloride. Calomel. Hg_2Cl_2.

Source.—Obtained as a sublimate when a mixture of Mercurous Sulphate and Sodium Chloride is heated.

Characters.—A dull white, heavy, nearly tasteless powder. *Solubility.*—Insoluble in water, alcohol 90 per cent., or ether; boiling concentrated nitric acid oxydises and dissolves it. Entirely volatilised by heat. *Impurities.*—Mercuric Chloride, soluble in warm ether; other chlorides, which are not volatile. *Dose*, $\frac{1}{2}$ to 5 gr.

Preparations.

a. Lotio Hydrargyri Nigra.—Black Mercurial Lotion. Black Wash. Calomel, 0·685; Glycerin, 5; Mucilage of Tragacanth, 12·5; Solution of Lime, to make 100. $Hg_2Cl_2 + Ca2HO = Hg_2O + CaCl_2 + H_2O$; the Black Oxide being formed.

b. Pilula Hydrargyri Subchloridi Composita.—Compound Calomel Pill. Plummer's Pill. Calomel, 25; Sulphurated Antimony, 25; Guaiacum Resin, 50; Castor Oil, 10·3; Alcohol 90 per cent., 3. *Dose*, 4 to 8 gr.

c. UNGUENTUM HYDRARGYRI SUBCHLORIDI.—Calomel Ointment. 1 in 10, with Benzoated Lard.

4. Hydrargyri Perchloridum. — Mercuric Chloride. $HgCl_2$. Corrosive Sublimate.

Source.—Obtained as a sublimate by heating a mixture of Mercuric Sulphate, Sodium Chloride and a little Black Oxide of Manganese. $HgSO_4 + 2NaCl + MnO_2 = HgCl_2 + Na_2SO_4 + MnO_2$. The Manganese prevents the formation of Calomel by setting free Cl, which converts the Subchloride into the Perchloride.

Characters.—Heavy colourless masses of prismatic crystals. *Solubility.*—1 in 16 of cold, 1 in 2 of boiling water; 1 in 3 of alcohol 90 per cent.; 1 in 4 of ether; 1 in 2 of cold glycerin on trituration. *Incompatible* with alkalis and their carbonates, potassium iodide, lime-water, tartar-emetic, silver nitrate, lead acetate, albumen, soaps, decoction of bark.

Impurities.—Fixed salts; detected by not volatilising.

Dose, $\frac{1}{32}$ to $\frac{1}{16}$ gr.

Preparations.

a. LIQUOR HYDRARGYRI PERCHLORIDI.—1 dissolved in 875 of Distilled Water. $\frac{1}{16}$ gr. of Mercuric Chloride in 1 fl.dr. *Dose*, 30 to 60 min.

b. LOTIO HYDRARGYRI FLAVA.—Yellow Mercurial Lotion. Yellow Wash. Mercuric Chloride, 0·46; with Solution of Lime, 100. $HgCl_2 + Ca(HO)_2 = HgO + CaCl_2 + H_2O$; the Yellow Oxide being formed.

From Hydrargyri Perchloridum are made:

c. **Hydrargyri Iodidum Rubrum.**—Mercuric Iodide. HgI_2. Biniodide of Mercury.

Source.—Precipitated by the interaction of Mercuric Chloride and Potassium Iodide.

Characters.—A vermilion crystalline powder. *Solubility.*—Almost insoluble in water; sparingly in alcohol 90 per cent.; freely and entirely in ether, or in solution of Potassium Iodide. Entirely volatilised by heat under redness. *Impurities*, as of the Perchloride. *Dose*, $\frac{1}{32}$ to $\frac{1}{16}$ gr.

Preparations.

a. LIQUOR ARSENII ET HYDRARGYRI IODIDI—Solution of Arsenious and Mercuric Iodides. Donovan's Solution.

Source.—Made by dissolving by trituration 1 each of Arsenious Iodide and Mercuric Iodide in 100 of Water.

Characters.—A clear pale yellow liquid, with a metallic taste. Contains 1 gr. each of AsI_3 and HgI_2 in 110 min. *Dose*, 5 to 20 min.

β. Unguentum Hydrargyri Iodidi Rubri.—Mercuric Iodide Ointment. 1; Benzoated Lard, 24.

d. **Hydrargyrum Ammoniatum.** — Ammoniated Mercury. NH_2HgCl. White Precipitate.

Source.—Made by precipitating a solution of Mercuric Chloride with diluted Solution of Ammonia; washing and drying. $HgCl_2 + 2NH_4HO = NH_2HgCl + NH_4Cl + 2H_2O$.

Characters.—An opaque white powder; insoluble in water, alcohol 90 per cent., and ether. *Impurities*, as of the Perchloride.

Preparation.

Unguentum Hydrargyri Ammoniati.—Ammoniated Mercury Ointment. White Precipitate Ointment. 1 in 10, with White Paraffin Ointment.

e. **Hydrargyri Oxidum Flavum.**—Yellow Mercuric Oxide. HgO.

Source.—Made by precipitating a solution of Mercuric Chloride with Sodium Hydroxide. $HgCl_2 + 2NaHO = HgO + 2NaCl + H_2O$.

Characters.—A yellow powder; insoluble in water; entirely volatilised by heat. Has the same composition as the Red Oxide, but is non-crystalline.

Preparation.

Unguentum Hydrargyri Oxidi Flavi.—Yellow Mercuric Oxide Ointment. 1; Soft Paraffin, yellow, 49.

f. **Hydrargyri Oleas.**—Mercuric Oleate.

Source.—Made by boiling a solution of Mercuric Chloride with a solution of Oleic Acid and Hard Soap in Water; and washing and drying the precipitate. A light greyish yellow substance, of unctuous consistence and saponaceous odour.

Preparation.

UNGUENTUM HYDRARGYRI OLEATIS.—Mercuric Oleate Ointment. 1; Benzoated Lard, 3.

GENERAL CHEMICAL CHARACTERS OF SALTS OF HYDRARGYRUM.

Solutions of Mercurous salts give a black precipitate with H_2S; and a white precipitate with HCl, blackened by NH_4HO. Those of Mercuric salts give a brown precipitate with H_2S; a scarlet with KI. The insoluble Mercurials are volatilised by heat.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Mercury and most of its preparations cause little irritation of the unbroken skin unless applied for some time; but all the stronger mercurial preparations are to be used with caution locally. On ulcers and mucous surfaces mercurials produce *four definite effects:*—1. Weak solutions of Mercuric Chloride ($\frac{1}{8}$—$\frac{1}{4}$ gr. to 1 fl.oz.), and the Ointments of the various salts, are **astringent, antiphlogistic and stimulant,** like the preparations of other metallic salts (*see* page 68). On this principle many inflammations of the skin and eyelids are treated with Red Precipitate, White Precipitate and Citrine Ointments. 2. Stronger solutions of Corrosive Sublimate cause inflammation of the skin, and concentrated solutions are **caustic.** Neither effect is employed surgically; but the Acid Solution of the Nitrate, also a powerful caustic, is used to destroy small growths on the skin. 3. All mercurials are **antiseptic and disinfectant,** especially Mercuric Chloride (*see* page 104). 4. Part of the application is absorbed very readily, and produces, both locally and generally, the **specific** effect of the metal to be described presently. The official Lotions are intended to have a local specific action, and are much used in syphilis. As it is frequently desirable to obtain the general effects of Mercury by local application, it will be well to describe here the various methods of thus administering the drug.

(1) *Inunction.*—In the form of the Ointment, metallic Mercury may be rubbed into a soft part of the skin. Thus applied, Mercury undoubtedly enters the blood; it has been contended, however, that the metal is not admitted by the skin, but through the lungs in the form of vapour arising from the heated body smeared with the Ointment, or even in

small particles by the mouth. Fortunately, the question is of little practical importance, the fact remaining that the system can be quickly brought under the influence of Mercury by inunction. The Oleate *painted* on the skin and the Liniment, Compound Ointment and Plaster *worn* on it also convey the metal into the body.

(2) *Fumigation.*—The vapour of Calomel, rising from a vessel heated by a lamp, is conducted to a part or to the whole of the surface of the body of the patient, and there allowed to settle as a fine deposit of the salt. The effect is increased by simultaneous diaphoresis, induced either by the vapour of water or by such a drug as Jaborandi. 20 gr. of Calomel may thus be fumigated, during a sitting of twenty minutes. The same doubt exists as to the precise way in which Calomel thus administered enters the system.

(3) *Baths.*—As a bath of dilute solutions of Mercuric Chloride, say 3 dr. to 30 gallons of water, with 1 fl.dr. of Hydrochloric Acid.

(4) *Endermically.*—Mercurials may be dusted on the raw surface of a blistered portion of the skin or soft syphilitic growths (condylomata).

(5) *Hypodermically.*—Various preparations of Mercuric Chloride, including albuminates and peptonates, may be injected under the skin or into the tissues. This method is powerful, and produces neither salivation nor gastric disturbance; but it is apt to cause troublesome local irritation.

(6) *Inhalations.*—The vapour of Mercurials may be inhaled, as we have seen; but this method is rarely employed intentionally.

(7) *Per rectum.*—Mercury may be given in the form of suppositories.

Whilst the specific action of the drug, presently to be described, is developed by these methods, the local effects are more marked: certain skin diseases are healed, condylomata removed, and indurations and chronic inflammatory processes in connection with bones or joints reduced.

Internally.—The local action of Mercury is the same internally as externally, according to the nature and strength of the preparation employed. Very dilute aqueous solutions of Mercuric Chloride (4 gr. to 10 fl.oz., with 8 min. of Hydrochloric Acid) may be used as a gargle or wash for syphilitic ulcers of the mouth. All the salts of Mercury act upon the mouth, gums and salivary glands, causing salivation and stomatitis; but these effects are due to their excretion, not

to their immediate influence on the parts, and will be described later.

In the stomach, Mercurials combine with the Sodium Chloride of the secretions, and, whatever their original form, are converted into a double Sodium and Mercury Chloride, which further unites with the albuminous juices to form a complex molecule of Mercury, Sodium, Chlorine and Albumen. This compound, although precipitated at first, is soluble in an excess either of Sodium Chloride or of Albumen; exists in the stomach, therefore, in solution; and is readily diffusible and easily absorbed. It is not specially irritant in moderate quantities, and none of the salts of Mercury given in medicinal doses produce vomiting like Zinc and Copper; indeed, Ringer has shown that Calomel in $\frac{1}{12}$ gr. doses, or Hydrargyrum cum Cretâ in $\frac{1}{3}$ gr. doses, given every two or three hours, arrests some forms of vomiting in children. This may be a **disinfectant** effect. In large or concentrated doses Mercurials are **irritant** or corrosive to the stomach, and should always be given cautiously and after meals.

The action of Mercurials in the duodenum takes the form of purgation. Mercuric Chloride is never employed to produce this effect, but Calomel and divided Mercury in the form of the Pilula Hydrargyri or Hydrargyrum cum Cretâ are common **purgatives.** The action of Mercurials as purgatives is mainly a local one, but some of the metal is absorbed only to be re-excreted, and the whole is expelled in the fæces. The same effect follows hypodermic injection of the drug. Probably the intestinal glands are stimulated to increased secretion, and the mucous membrane is irritated to such a degree as to produce a moderate increase of watery exudation from its vessels into the bowel, peristalsis also becoming more brisk. At the same time the putrefactive (bacterial) factor of duodenal digestion and its attendant flatulence are checked. The gall bladder and bile ducts are believed to be stimulated also. The result is thorough evacuation of the contents of the small intestine, as large, loose, possibly green, but not watery stools, charged with products of pancreatic digestion, and with bile which has been hurried out of the duodenum, and not decomposed or allowed to re-enter the portal circulation by absorption from the lower bowel, as it normally does. Thus Mercurials, particularly Calomel, increase the amount of bile evacuated without *directly* increasing the amount secreted; that is, are **indirect cholagogues** by being duodenal purgatives. The manner in which indirect cholagogue action stimulates the liver to further secretion is discussed on p. 514. **The purgative action of Mercurials is greatly assisted by a** subsequent

saline, such as Seidlitz Powder or Mistura Sennæ Composita. The class of diseases in which Mercurials are selected as purgatives chiefly includes congestion of the portal system and liver, especially those referable to secondary indigestion from free living or gout; constipation attended by irritable stomach, or actual ulceration of the stomach or bowels; very rarely habitual constipation, except at long intervals to enable gentle laxatives to act more freely. Diarrhœa, distinctly referable to the presence of putrefactive organisms within the bowel, particularly in children, is rationally treated with salts of Mercury, which act as **intestinal disinfectants.**

2. ACTIONS ON THE BLOOD.

As we have seen, Mercury enters the blood freely through the broken or unbroken skin. From the bowel but a small part of a medicinal dose is absorbed, the rest passing off in the fæces as the sulphide. Opium delays its progress through the intestine. The complex molecule which Mercury forms in the stomach and intestines is decomposed on entering the blood by combination with Oxygen and Albumen, a Mercury Oxyalbuminate being the result; and apparently the same compound is formed when the metal enters by other channels.

No *direct* effect on the blood can be attributed to Mercury; but an impairment of nutrition generally, including digestion, attends its excessive use, and induces impoverishment both of the plasma and the corpuscles, *indirectly* referable to the drug. The blood becomes more watery and coagulates less firmly, and nutrition may be further disordered in consequence, with the production of low forms of inflammation and ulceration. It is understood that this is not a specific effect of Mercury, and that the influence of Mercury upon inflammatory products and syphilitic growths, to be presently described, is not exerted through the blood but upon the tissues themselves. Still, the impoverishing effect of this drug upon the blood must be kept constantly in mind, and the quality of the blood sustained by abundance of food and strict attention to digestion. If the appetite fail, or serious dyspepsia arise, Mercurials must be stopped.

3. SPECIFIC ACTIONS.

Mercury quickly leaves the blood and enters the tissues, where it is apt to remain almost indefinitely, being excreted with comparative slowness, especially when the kidneys are diseased. It has been found in every organ of the body, most abundantly in the liver. It is a remarkable fact, however, that no marked pathological change has ever been demon-

strated in the viscera, such as the vessels, liver or nervous system, even in cases of chronic poisoning by this metal, beyond slight inflammatory lesions and ulcerations in the alimentary canal, osseous softening and traces of spinal myelitis. Mercury in this respect also differs from Lead, Silver, Antimony and Arsenium. Whilst, therefore, the specific effects of Mercury are unquestionable, its *mode* of action is still obscure, and numerous theories have been proposed to account for it, which need not be fully discussed here. All that can be said is that in some way or other Mercury interferes with the growth or life of certain germinal cells, and that it has therefore a controlling influence on such processes as inflammation and syphilis, which are characterised by germinal activity. Possibly it may have a destructive influence on some ferments or organisms connected with physiological and pathological metabolism, one of these being the virus of syphilis.

Whatever may be the explanation of its action, Mercury given for a considerable period in moderate doses may (but by no means necessarily does) produce a train of symptoms known as "hydrargyrism," which chiefly take the form of swelling of the gums, salivation, dyspepsia and diarrhœa; ulceration of the mouth, mucous membranes and skin; pains in the bones, nervous phenomena, including muscular tremors, paralysis and mental disturbance; cardiac depression; debility, anæmia and cachexia. Some of these effects may be permanent. The temperature is not directly raised, nor are the total excretions more abundant, so that there is no positive evidence of increased metabolism as an effect of Mercury.

4. SPECIFIC USES.

The uses of Mercury as a specific remedy bear no definite relation to these effects, which have been mentioned chiefly that they may be recognised and arrested. The principal application of the drug is in syphilis, a disease attended by the growth of cells around the small vessels, and the development of these into nodes, gummata, various eruptions, etc. Mercury has a powerful influence in controlling the severity of this disease. Its employment may be commenced with various local applications to the primary sore, and regular internal doses of the Solution of Mercuric Chloride, Calomel, Grey Powder or some of the other preparations, until salivation threaten. In the opinion of the highest authorities the secondary stage is rendered less severe or is entirely prevented by this means. The drug must be continued during

secondary symptoms; as a rule, it is rarely required in the tertiary stage. The particular preparation employed varies with the experience of the practitioner. Quinine and Opium are useful means of support to be combined with Mercury in a course of the metal, and we must repeat that unless the appetite and digestion continue good the use of it must be interrupted.

The other specific use of Mercurials is in internal inflammations, especially iritis and inflammation of serous membranes—peritonitis, pericarditis, pleurisy, meningitis and orchitis. This line of treatment, once universal in England, is now almost obsolete, excepting, perhaps, in subacute or chronic peritonitis. Used as an antiphlogistic, Mercury is usually combined with Opium. Possibly some of the benefit thus attending mercurialisation in inflammation, and formerly referred to its "resolvent" action on the fibrin of exudations, is due to its purgative and indirect cholagogue effects, or to the syphilitic nature of the process.

5. REMOTE LOCAL ACTIONS AND USES.

Mercury slowly passes out of the system in all the secretions (the saliva, sweat, milk, urine and bile), probably as an albuminate, and stimulates many of the glands *en route*. It is in this way, as we have seen, a powerful **sialagogue**, causing swelling of the salivary glands and a profuse flow of the secretions of the mouth. This effect is to be avoided. The diaphoretic effect of Mercury is comparatively insignificant; various eruptions may occur. Given in 3-gr. doses four times a day for three or four days on end (the mouth being watched), Calomel occasionally produces a remarkable effect as a **diuretic** in cardiac dropsy. It also assists to a marked degree such diuretics as Digitalis and Squill; but it must be given with caution in kidney disease, as it may cause albuminuria, is believed to set up or aggravate inflammation of the tubules, and readily produces its debilitating effects when the renal function is impaired. In the fæces Mercury leaves the body as the sulphide, which is derived, first, from that considerable portion of the dose which is not absorbed; secondly, from the portion excreted by the liver (in the bile), and by the salivary, pancreatic and intestinal glands. But little use is made of the remote local action of Mercury.

6. ACTIONS AND USES OF THE DIFFERENT PREPARATIONS OF MERCURY.

The preparations of Mercury, although so numerous, are

readily remembered, and their special actions understood, when grouped as follows :—

1. *Metallic Mercury* and preparations containing it.

2. *Mercuric Chloride* and its preparations.

3. *Mercurous Chloride* and its preparations.

4. The *Oxides*, *Iodides*, *Ammoniated Mercury*, *Oleate* and preparations : a complex group, the action and uses of which correspond mainly with those of Mercuric Chloride, partly with those of Mercurous Chloride.

5. *Acid Solution of Mercuric Nitrate* and the Ointment.

1. Metallic Mercury and its preparations.—These may be employed in all the classes of cases for which Mercurials are adapted. The metal itself is never given internally, except in the finely divided form in which it exists in Pilula Hydrargyri and Hydrargyrum cum Cretâ. The Blue Pill is chiefly used as a purgative and indirect cholagogue, but is also given for syphilis in small doses combined with Opium and Quinine, and as a diuretic along with Digitalis and Squill (the famous "Guy's Pill"). Hydrargyrum cum Cretâ is a favourite purgative for children, and also a convenient preparation for a course of Mercury in syphilis. Unguentum Hydrargyri is the usual means of administering the metal by inunction. A portion as large as a pea or hazel nut is rubbed daily into the inside of the thigh, or smeared on flannel and applied round the loins, the gums being carefully watched. The latter is a very sure and tolerably safe but very dirty method, which is chiefly employed in infants. Mercury Ointment may also be smeared over inflamed parts, such as the testis ; and it is used as a parasiticide. The Liniment of Mercury (the Ointment as a liquid soap) is soaked on lint and applied to chronically inflamed parts like the joints or the abdomen. The same use may be made of the Plasters, and of the Compound Ointment, "Scott's Dressing." A suppository may be used in syphilis, or to kill ascarides.

2. Mercuric Chloride.—This is the most powerful of all Mercurials. It is one of the most active of antiseptics. 1 part in 10,000 destroys micrococci and bacilli ; 1 in 1,000 destroys their spores. A solution of the former strength is suitable as an ordinary lotion for wounds ; the latter strength may be used as a spray or wash in diphtheria, and to disinfect foul ulcers, especially of syphilitic origin ; and a solution of 1 in 500 may be employed with care. It is much used as an antiseptic dressing in combination with cotton wool, wood wool,

etc. It is also applied in ringworm, pityriasis versicolor, and other parasitic skin diseases. Internally, the Liquor is well borne and efficient in syphilis. It serves also as a disinfectant in some kinds of diarrhœa. A solution—8 gr. to 1 fl.oz. of Distilled Water, with 8 gr. of Ammonium Chloride ("sal alembroth")—and albuminates and peptonates have been used for interstitial injection in syphilis. Lotio Hydrargyri Flava is applied to syphilitic sores. As a general disinfectant, 1 of Mercuric Chloride in 500 of Water is thoroughly efficient.

3. Mercurous Chloride.—Calomel resembles metallic Mercury in being used both externally and internally as a stimulant, disinfectant, antisyphilitic and purgative remedy. Externally it is applied to the inflamed cornea, syphilitic sores, and chronic inflammatory growths as Calomel dust; by fumigation; as the Unguentum, and as the Black Wash. Internally, Calomel is a valuable purgative possessing also the action of a disinfectant. It is readily taken and easily borne even in irritable states of the stomach; and acts as an indirect cholagogue, hepatic stimulant and diuretic. The Compound Calomel Pill is in much repute as a hepatic and metabolic stimulant, with little or no directly purgative effect, to be given every night or every other night, for a week or more at a time, in gout and other morbid conditions consequent on free living. Calomel combined with Opium was the favourite Mercurial prescribed by the last generation of surgeons and physicians in the treatment of inflammation; in syphilis it is still employed with success.

4. The Oxides, Iodides and Ammoniated Mercury.—These substances, although forming a convenient group, chiefly belong to the second group named as regards their action and uses. Thus the following closely resemble Mercuric Chloride, viz. Hydrargyri Oxidum Flavum, Hydrargyri Oxidum Rubrum, Hydrargyri Iodidum Rubrum, and Hydrargyrum Ammoniatum. The first two are chiefly used externally in syphilis and chronic inflammations of the skin and eyes. The Oleate is used in syphilis and inveterate ringworm. The "White Precipitate Ointment" is useful as a parasiticide and an application to chronic inflammatory (infective) eruptions in children.

With Mercurous Chloride may be classed the Green or Mercurous Iodide, no longer official because unstable and therefore dangerous, but still used by some surgeons. The student will not forget that Lotio Hydrargyri Flava really contains the Yellow Oxide, and Lotio Hydrargyri Nigra the Black Oxide, although they are reckoned preparations of Mercuric

Chloride and Mercurous Chloride respectively. Donovan's Solution is valuable in obstinate syphilides.

5. Liquor Hydrargyri Nitratis Acidus and Mercuric Nitrate Ointment.—These are not used in syphilis. The former is applied as a caustic in lupus and other limited growths and ulcers of the skin; the Ointment as a stimulant to chronic skin diseases, and to the edges of the eyelids in chronic inflammation and ulceration of the follicles.

Precautions in the use of Mercurials.—Mercury must not be given to persons with anæmia or debility, unless these are distinctly referable to syphilis, and even then it must be employed with caution. This remark also applies to tuberculosis and renal disease. Individuals are occasionally met with in whom even small doses of Calomel or Blue Pill quickly induce hydrargyrism from a kind of idiosyncrasy. In every instance the patient must be carefully nourished, as we have said. On the contrary, children, even infants, bear Mercury very well, although the prolonged administration of the metal to them appears to produce a peculiar change in the permanent teeth when they appear, which is extremely unsightly (mercurial teeth of Hutchinson).

SUB-GROUP 4.

PHOSPHORUS, ARSENIUM, ANTIMONIUM, BISMUTHUM.

PHOSPHORUS. PHOSPHORUS. P. 30·80.

Under this head will be described not only the element itself, but the Hypophosphites, which are derived from it, and are believed to be closely related to it pharmacologically.

Phosphorus.—A solid non-metallic element obtained from Calcium Phosphate.

Characters.—A semi-transparent, wax-like solid; luminous in the dark; ignites in the air. Sp. gr. 1·77; melts at 110° F. *Solubility.*—Insoluble in water, 1 in 350 of absolute alcohol, 1 in 80 of olive oil and of ether, 1 in 25 of chloroform, 2 in 1 of carbon bisulphide, and in boiling oil of turpentine. *Dose*, in pill or solution, $\frac{1}{100}$ to $\frac{1}{20}$ gr.

Preparations.

1. **Oleum Phosphoratum.** — Phosphorated Oil.—1 dissolved at 180° F. in 99 of Almond Oil, previously heated for 15 minutes to 300° and filtered. *Dose*, 1 to 5 min.

2. **Pilula Phosphori.** — 1; Lard, 12·5; White Beeswax, 12·5; Kaolin, 11·5; Carbon Bisulphide, 3·3. When dispensed every 3 grains of this mixture is to be incorporated with 1 grain of Gum Acacia powdered; the resulting pill (2 per cent. of P.) should be varnished. *Dose*, 1 to 2 gr.

From Phosphorus is made:

3. **Calcii Hypophosphis.** $Ca(PH_2O_2)_2$.

Source.—Obtained by the interaction of Phosphorus, Calcium Hydroxide and Water. $3CaH_2O_2 + 2P_4 + 6H_2O = 3Ca(PH_2O_2)_2 + 2PH_3$.

Characters.—White pearly crystals, with a bitter nauseous taste. *Solubility.*—1 in 8 of cold water; insoluble in cold alcohol 90 per cent. *Dose*, 3 to 10 gr.

Calcii Hypophosphis is used in making:

Sodii Hypophosphis. $NaPH_2O_2$.

Source. — Obtained by the interaction of Sodium Carbonate and Calcium Hypophosphite. $Ca2PH_2O_2 + Na_2CO_3 = 2NaPH_2O_2 + CaCO_3$.

Characters.—A white, granular, deliquescent salt, with a bitter nauseous taste. *Solubility.*—1 in 1 of water; 1 in 30 of alcohol 90 per cent.; insoluble in ether. *Dose*, 3 to 10 gr.

Phosphorus is also used in making:

Acidum Phosphoricum Concentratum.

GENERAL CHEMICAL CHARACTERS OF PHOSPHORUS AND HYPOPHOSPHITES.

Phosphorus is luminous when opened in a dark place. *Hypophosphites* give a black precipitate with $AgNO_3$; a grey with $HgCl_2$. With Zn and H_2SO_4 they yield PH_3. Acid solutions decolorise $KMnO_4$.

ACTIONS AND USES.

Phosphorus has a powerful action on the body, and one which has been proved by elaborate investigations on animals to be of the most interesting kind to the physiologist. As a poison Phosphorus is also of great importance. Unfortunately, however, it cannot be said to be of much value to the therapeutist, as it has disappointed most attempts to turn it to practical account in the treatment of disease.

1. IMMEDIATE LOCAL ACTIONS.

Externally and internally Phosphorus acts as a powerful local **irritant and caustic**; but it is never given to produce this effect. For the same reason the drug must not be ordered in the solid form, but carefully mixed with oil or fat. The Phosphorated Oil is best administered on sugar or in perles.

2. ACTIONS ON THE BLOOD, AND USES.

Phosphorus enters the blood, and may be found in it partly unchanged, partly oxydised into phosphorous or phosphoric acid at the expense of the oxygen of the red corpuscles. The specific effects to be presently described cannot, however, be accounted for by interference with the oxygenating function of the blood. Phosphorus has been employed in leukæmia and lymphadenoma, but on the whole with disappointing results.

3. SPECIFIC ACTIONS AND USES.

In the tissues Phosphorus may be traced as the uncombined element; another proof that its oxydation in the blood is incomplete. Its effect on metabolism, when given in large doses, is most distinct and definite. It increases the nitrogenous products, including urea, tyrosin and leucin; reduces the glycogen of the liver to *nil;* raises the temperature; diminishes the excretion of carbonic acid, and the volume of oxygen absorbed; and leads to fatty degeneration of epithelial, glandular and muscular protoplasm throughout the body. No doubt these effects are essentially associated with each other; Phosphorus, whilst **increasing metabolism**, so influencing it as to diminish oxydation, and thus to arrest the process at the first stage where proteids are converted into urea and oil, instead of allowing it to proceed to the second and final stage where the oil is further oxydised into carbonic acid and water. Hence all the results just enumerated: whilst the soluble products (urea, etc.) are excreted, the insoluble pro-

ducts (oils or fats) are retained in the tissues, constituting **fatty degeneration.**

The uses to which Phosphorus has been put as a specific remedy do not obviously depend on these effects upon nutrition. It has been given in nervous disorders, such as neuralgia; in adynamic conditions, such as typhoid fever; in some skin diseases, including pemphigus, psoriasis, and lupus erythematosus, and as an aphrodisiac. It is difficult to understand how these morbid states can be benefited by a substance which diminishes oxydation; but Lecithin (a phosphorised fat) and Glycerophosphoric Acid, one of its constituents (non-official), are used to stimulate metabolism.

In very small doses over a considerable length of time, Phosphorus affects the structure of bones, converting the spongy portion into firm, compact substance, without altering its composition chemically. It has therefore been recommended in rickets and for ununited fracture; but in rickets, at least, is far inferior to certain other medicinal measures.

Sodium and Calcium Hypophosphites.—The Hypophosphites have recently been much employed in cases of nervous and general debility, and in chronic pulmonary disease. They act, according to some authorities, in the same manner as free Phosphorus, without being irritant. As the Hypophosphites are probably converted into phosphates in the stomach, they may be expected to stimulate the liver and bowels, and (especially the calcium salt) to affect the growth and healing of bones, lymphatic glands, and adenoid tissue, including tubercle.

4. REMOTE LOCAL ACTION.

Phosphorus is excreted by the kidneys as Phosphorus and phosphorous acid, not as phosphates. It is not employed in this connection.

ARSENIUM. Arsenium. As. 74·5.

All the preparations of this metal are derived from White Arsenic.

Acidum Arseniosum. — Arsenious Anhydride As_4O_6. Arsenious Acid. White Arsenic.

Source.—Obtained by roasting certain arsenical ores.

Characters.—A heavy white powder; or stratified, opaque, white porcelain-like masses. *Solubility.*—1 in 100 of cold, 1 in 10 of boiling, water, yielding an odourless, tasteless, faintly

acid solution; 1 in 5 of glycerin. Volatilised at 400° F. *Incompatibles.*—Salts of iron and magnesium; lime water. *Impurities.*—Lead, Cadmium, Antimony, Tin; and sulphides.

Dose, $\frac{1}{60}$ to $\frac{1}{15}$ gr. (in solution or pill, after meals).

Preparations.

1. **Liquor Arsenicalis.**—"Fowler's Solution."

Source.—Made by boiling Arsenious Anhydride and Potassium Carbonate in Water; and colouring with Compound Tincture of Lavender. 1 in 100. It is doubtful whether any decomposition occurs.

Characters.—A reddish liquid, alkaline to test-paper, with the odour of lavender. *Dose*, 2 to 8 min.

2. **Liquor Arsenici Hydrochloricus.**—Hydrochloric Solution of Arsenic.

Source.—Made by boiling Arsenious Anhydride with Hydrochloric Acid and Water. 1 in 100. No decomposition occurs. *Characters.*—Colourless, with an acid reaction. *Dose*, 2 to 8 min.

From Acidum Arseniosum are made:

3. **Sodii Arsenas.**—Sodium Arsenate. Na_2HAsO_4.

Source.—Made by (1) fusing Arsenious Anhydride with Sodium Nitrate and Carbonate; (2) dissolving the product in Water, and crystallising; and (3) heating to 300° F. (1) $As_4O_6 + 4NaNO_3 + 2Na_2CO_3 = 2Na_4As_2O_7$ (Sodium Pyro-Arsenate) $+ N_2O_3 + CO_2$. (2) $Na_4As_2O_7 + H_2O = 2Na_2HAsO_4$.

Characters.—A white powder. *Solubility.*—1 in 6 of water; the solution is alkaline. Heated to 300° F., it should not lose weight. *Impurities.*—Other metals; carbonates, chlorides, nitrates and sulphates.

Dose, $\frac{1}{40}$ to $\frac{1}{10}$ gr.

Preparation.

LIQUOR SODII ARSENATIS.—1 in 100 of Distilled Water. *Dose*, 2 to 8 min.

From Arsenate of Sodium is made:

Ferri Arsenas. See *Ferrum*, page 82.

4. **Arsenii Iodidum.**—Arsenious Iodide. AsI_3.

Source.—Made by the direct combination of Iodine and Arsenium.

Characters.—Small orange-coloured crystals. *Solubility.*—Soluble in water and in alcohol 90 per cent. Aqueous solution is neutral. *Dose*, $\frac{1}{20}$ to $\frac{1}{5}$ gr.

Preparation.

LIQUOR ARSENII ET HYDRARGYRI IODIDI.—Donovan's Solution. See *Hydrargyrum*, page 96.

GENERAL CHEMICAL CHARACTERS OF SALTS OF ARSENIUM.

Arsenic volatilises by heat, emitting the odour of garlic. It also gives Marsh's and Reinsch's tests. Acid arsenical solutions give a yellow precipitate with H_2S; Arsenates give a chocolate precipitate with $AgNO_3$.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Arsenious Acid is irritant and **caustic**. It is used occasionally to destroy lupus, epithelioma, and other superficial or limited new growths, in the form of a "paste," composed of Arsenious Acid 1, Charcoal 1, Red Sulphuret of Mercury 4, and Water. Arsenic must be used locally with great care, as it is absorbed from the broken skin, ulcers, and mucous membranes, unless sufficient inflammation be set up to throw it off.

Internally.—The local corrosive action of Arsenic may be employed in caries of the teeth to destroy the painful pulp before stopping, a paste chiefly composed of Arsenious Acid, Cocaine, Morphine Sulphate and a sufficiency of Creosote to make a stiff compound being placed in the cavity.

Reaching the stomach in medicinal doses, the preparations of Arsenic do not combine with the albuminous contents like Mercury, but remain unchanged. They thus act upon the mucous membrane, stimulating the nerves and vessels, causing a sense of heat and hunger, and increasing the gastric functions. In these small doses Arsenic is employed with advantage in some cases of gastric dyspepsia; and a similar effect on the duodenum makes it of value in lienteric diarrhœa. If the dose be increased, the stimulant action may readily pass into **irritation of the stomach**, attended by pain and sickness, and diarrhœa from intestinal disturbance. These symptoms, which we shall find to be partly due to the excretion of the metal, are to be remembered only that they may be avoided, or arrested if they should arise.

2. ACTIONS IN THE BLOOD, AND USES.

Arsenic quickly enters the blood, and is believed to increase the number and activity of the phagocytes, and indirectly the amount of hæmoglobin. It has been used with success in some forms of anæmia; and this both in idiopathic forms (pernicious anæmia, leukæmia) and where the corpuscles and plasma have suffered from failure of nutrition elsewhere (symptomatic anæmia), as in tuberculosis, malaria, gout and rheumatism. Alone, or combined with Iron, it has sometimes an excellent effect in restoring the blood in such cases.

3. SPECIFIC ACTIONS AND USES.

Arsenic enters all the organs and tissues, but is not known to combine with their albuminous constituents; it remains in them for a short time only, and is quickly excreted. During this period, however, it distinctly influences metabolism; according to Binz, by alternate oxydation of Arsenious into Arsenic Acid at the expense of the protoplasm, and reduction of the higher Acid again into the lower by the venous and capillary blood. It first reaches the liver, and reduces the amount of glycogen in it, so that it may be occasionally, but by no means often, used with success in diabetes mellitus. In the other organs it interferes similarly with metabolism, apparently (like Phosphorus) through the oxygenating process. An increased amount of nitrogenous waste appears in the urine; the temperature rises; and the excessive fatty product of the albuminous decomposition remains unexcreted, constituting fatty degeneration. Short of this effect, Arsenic appears to produce a wholesome increase of the metabolism or vital activity of all the organs; and it is perhaps in this way that the drug acts as a general **tonic**, and as a valuable remedy in such classes of disturbed nutrition as gout and chronic rheumatism. For the same reason it hastens the degeneration and absorption of inflammatory products in catarrhal pneumonia and phthisis. It is possible, however, that Arsenic affects the life processes of other living particles in the body besides the tissue elements, namely, the organisms of certain diseases. It is, next to Quinine, the most successful medicinal agent in the treatment of chronic malaria, brow-ague and other varieties of neuralgia due to the same cause, and malarial cachexia; and it is used with advantage in hay-fever. It sometimes dispels lymphomatous tumours. Beyond a safe amount, Arsenic produces a series of nutritive disorders in the tissues, characterised chiefly by debility and nervous disturbances,

known as "chronic arsenical poisoning," which need not be detailed here.

Next to nutrition generally, the nervous system appears to be most influenced by Arsenic. It is found abundantly in the grey matter of the cord in cases of poisoning, and acts by diminishing the sensibility and reflex irritability of the centres. The motor nerves and muscles are affected later (peripheral neuritis), particularly when Arsenic is imbibed along with Alcohol in impure beer. Arsenic is useful in chorea, neuralgia, and asthma, especially when malaria, gout, or anæmia is associated with the neurosis. Like Phosphorus, Arsenic increases the compact tissue of bone at the expense of the medullary tissue, and is given sometimes in osteo-arthritis. In large doses it has a depressing effect on the respiration, circulation and temperature.

4. REMOTE LOCAL ACTIONS AND USES.

Arsenic is excreted chiefly in the urine, in the form of arsenious acid: also by the gastro-intestinal mucosa, the liver, and skin. It is not known to affect the kidney specially, but is sometimes used in chronic Bright's disease. The gastro-enteric irritation set up by over-doses of Arsenic appears to be chiefly produced during the excretion of the metal, not as an immediate local effect. The liver, as we have seen, is modified in its activity; and part of the value of Arsenic in chronic gout, gravel and skin diseases may be referable to its action on the greatest metabolic organ in the body. Either indirectly, or directly, its effect on the skin is very marked. It is the most valuable of all internal remedies for certain eruptions obviously connected with disordered nutrition, such as psoriasis, hydroa, chronic (not *acute*) eczema, lichen planus, and pemphigus; whilst it may cause herpes, pigmentation and keratosis, and aggravate erythema multiforme. Donovan's Solution is used in syphilides. Iron Arsenate checks night sweats in phthisis.

5. METHODS OF ADMINISTERING ARSENIC, AND PRECAUTIONS IN ITS USE.

Arsenical preparations should always be given immediately at the end of meals, unless its gastric effect be distinctly desired, which is rarely the case; and it ought not to come into free contact with the exposed mucous membrane. For the same reason it must be given with special caution if dyspepsia be present. Epigastric fulness, pain and tenderness, a sense of constriction in the throat, irritation or sore-

ness of the conjunctivæ, and especially vomiting, ought to suggest a diminution (not necessarily the suspension) of the drug. Children bear Arsenic well, whilst old subjects are said to bear it badly. A combination of Iron with Arsenic is one of the best of hæmatinics and tonics, probably because the Iron provides sufficient oxygen to complete the increased metabolism produced by the Arsenic. Weight for weight of the metal, the Arsenates are less active than the Arsenites. Sodium Cacodylate, $As(CH^3)_2O_2Na$, containing 48 per cent. of Arsenium, is given hypodermically in tuberculosis and other chronic infections.

ANTIMONIUM. ANTIMONY. Sb. 119.

The metal itself (Stibium) is not official, all the preparations being derived from Antimonious Sulphide, as follows :

Antimonium Nigrum Purificatum.—Antimonious Sulphide.

Source.—Native Antimonious Sulphide, Sb_2S_3, purified from silicious matter by fusion and powdering ; and from Arsenic by digestion with Solution of Ammonia, washing and drying.

Characters.—A greyish-black crystalline powder ; decomposed on boiling with hydrochloric acid. *Impurities.*—Arsenium ; Silica, insoluble in boiling HCl.

From Antimonium Nigrum Purificatum are made :

1. **Antimonium Sulphuratum.**—Sulphurated Antimony. A mixture containing Antimony Sulphides and Oxides, Sb_2S_5, Sb_2O_5, Sb_2S_3, Sb_4O_6 ; and S.

Source.—Made by (1) boiling Antimonious Sulphide with Sublimed Sulphur and Caustic Soda ; diluting with boiling water ; and (2) precipitating with Diluted Sulphuric Acid, washing, and drying.

Characters.—A dull-red powder, without odour, and with a slight taste. Readily soluble in solution of NaHO, also in hot HCl with evolution of H_2S, the solution yielding a white precipitate with water. *Impurity.*—Arsenium. *Dose*, 1 to 2 gr.

Antimonium Sulphuratum is contained in Pilula Hydrargyri Subchloridi Composita—about 1 in 4½. See *Hydrargyrum*, page 95.

2. **Liquor Antimonii Chloridi** (non-official).—

Solution of Antimonious Chloride, $SbCl_3$, in Hydrochloric Acid.

Source.—Made by dissolving Antimonious Sulphide in Hydrochloric Acid. $Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S$.

Characters.—A heavy liquid, colourless when pure; giving a white precipitate when dropped into water.

From Solution of Antimonious Chloride is made:

Antimonii Oxidum.—Antimonious Oxide. Sb_4O_6.

Source.—Made by (1) pouring Solution of Antimonious Chloride into Water; and (2) decomposing the precipitated Antimony Oxychloride with Sodium Carbonate.

Characters.—A greyish white powder, insoluble in water; readily in HCl. *Impurities.*—Higher oxides, insoluble when boiled with acid potassium tartrate; other metals. *Dose*, 1 to 2 gr.

Preparation.

a. PULVIS ANTIMONIALIS.—A substitute for "James's Powder." 1, with 2 of Calcium Phosphate. *Dose*, 3 to 6 gr.

From Antimonii Oxidum is made:

b. **Antimonium Tartaratum.**—Tartarated Antimony. Potassio-tartrate of Antimony. Tartar Emetic. $[K(SbO)C_4H_4O_6]_2H_2O$.

Source.—Made by preparing a paste of Antimonious Oxide and Acid Potassium Tartrate with water; setting aside until combination takes place; and purifying by crystallisation from water. $(CHOH)_2COOH{\cdot}COOK + Sb_2O_3 = [K(SbO)C_4H_4O_6]_2H_2O$.

Characters.—Colourless transparent crystals, exhibiting triangular facets. Taste sweet and metallic. *Solubility.*—1 in 17 of cold, 1 in 3 of boiling, water; slightly soluble in weak alcoholic liquids; almost insoluble in alcohol 90 per cent. Solution is faintly acid. *Incompatibles.*—Tannic acid and most astringent infusions (not gallic acid), alkalis, lead salts. *Impurities.*—Cream of tartar, detected volumetrically and by solubility; other metals. *Dose.*—As a diaphoretic, $\frac{1}{24}$ to $\frac{1}{8}$ gr. (as a depressant, $\frac{1}{6}$ to 1 gr.); as an emetic, 1 to 2 gr.

Preparation.

VINUM ANTIMONIALE.—4; boiling Distilled Water 44; Sherry to make 875. Contains ¼ gr. in 1 fl.dr. *Dose*, 10 to 30 min.; as an emetic, 2 to 4 fl.dr.

GENERAL CHEMICAL CHARACTERS OF ANTIMONIUM SALTS.

Salts of Antimonium give an orange precipitate with H_2S, and can be detected by Marsh's and Reinsch's tests.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Antimony, in the form of the Chloride, is an **escharotic**, employed chiefly in veterinary practice, occasionally by the surgeon as an application to poisoned, foul or malignant surfaces. Tartarated Antimony applied to the skin, either in aqueous solution or as an ointment (half a drachm at a time, repeated), causes a pustular eruption, and was once used as a **counter-irritant** in diseases of the lungs, joints, or meninges. Antimony is freely absorbed from the broken skin, and from mucous surfaces.

Internally, the local action is equally irritant. In doses of 1 to 2 grains Tartarated Antimony is an **emetic**, whence its popular name. The effect is partly direct, due, that is, to the irritant action of the drug upon the walls of the stomach; partly indirect, from immediate stimulation of the vomiting centre in the medulla. Further, its direct effect on the stomach is produced not only when the salt is admitted to it by the mouth, but after it reaches the stomach by the blood, that is, when it is being excreted by the gastric mucosa. Thus, whilst Tartar Emetic induces vomiting most quickly when swallowed, it is not speedy and evanescent in its effects, but causes both previous and subsequent nausea and depression. It is not suited, therefore, for use in cases of poisoning, where rapid evacuation is of the first importance, or where there is much general depression; but in the first stage of acute inflammatory diseases, with sthenic fever, in strong healthy subjects. It is especially indicated in respiratory affections, such as laryngitis and bronchitis, where its remote effects as an expectorant are valuable; or to clear the air-passages in the same diseases or in whooping cough.

In smaller continued doses the local action of Tartarated Antimony on the stomach and bowels is apt to produce loss of appetite, nausea, pain and diarrhœa.

2. ACTIONS IN THE BLOOD.

Antimony enters the blood either from within or from without, but does not appear to combine with the albumen of the plasma. No special action or use has to be mentioned under this head.

3. SPECIFIC ACTIONS AND USES.

Having reached the tissues and organs, Antimony clings to them with some tenacity, and may be found in them months after its administration. Here it sets up a series of important changes, attended by phenomena referable to the general nutrition of the body, to the circulation, respiration, and nervous and muscular systems; besides the effects to be afterwards described as referable to its excretion.

The effect of Antimony on *metabolism* closely resembles that of Phosphorus and Arsenic, to the account of which the student is referred. Briefly, the principal results are fatty degeneration of the organs and increase of the nitrogenous products, oxygenation being comparatively deficient. Upon this **influence on metabolism** depends in part the value of Antimony in gout, chronic skin diseases, etc., to be afterwards described. The *circulation* is depressed from the first by Tartarated Antimony. Even in small doses it reduces the strength and very soon the frequency of the pulse, which tends to become irregular, whilst fainting may occur; these effects being due to the action of the drug, first, upon the heart (partly directly on its nervo-muscular substance, partly reflexly from the stomach), and, secondly, upon the vessel walls. Antimony is thus a powerful **circulatory depressant.** The *respiratory* movements are also weakened and disturbed by this drug, which causes shortness of inspiration and lengthening of expiration, manifestly a minor degree of the disturbance which culminates in vomiting, and allied to the process of expectoration. The *nervous system* is markedly depressed by Antimony, in part directly, in part indirectly through the circulation, the effect of a moderate dose being to produce a sense of languor, inaptitude for mental exertion, lowness and sleepiness. Tartarated Antimony has accordingly been used as a **sedative** in the delirium and insomnia of fevers, such as typhus, and in acute alcoholism (delirium tremens), combined with Opium in various proportions.

The *muscular system* is so powerfully depressed by Antimony that, before the introduction of Chloroform, it was employed to produce muscular relaxation in the reduction of

herniæ and dislocations. Nauseating and emetic doses cause great weakness of the voluntary movements, inability to stand, occasional tremors, and aching of the muscles. Tartar Emetic is still given as an **antispasmodic.**

4. REMOTE LOCAL ACTIONS AND USES.

Antimony leaves the system by all the mucous surfaces, the liver, kidneys and skin; so that it may cause inflammation, salivation and pustulation of the mouth, and catarrh and ulceration of the œsophagus, stomach and ileum, even when administered by the skin. In being excreted by the *stomach*, it produces there, as we have seen, a remote emetic effect. Its excretion in the *bile* constitutes it a hepatic stimulant; Sulphurated Antimony, either as Plummer's Pill or alone, being much esteemed as a **cholagogue**, especially in gout and loaded conditions of the liver. In passing through the *kidneys* it has a slightly diuretic action. In doses of $\frac{1}{10}$ to $\frac{1}{8}$ gr., Tartarated Antimony stimulates the skin, acting as a diaphoretic, of service in feverish conditions. Its internal use occasionally develops the characteristic pustular eruption, which suggests it as a remedy for certain kinds of chronic skin disease, such as acute and subacute general eczema, prurigo, and some instances of psoriasis. Antimonial Wine is a familiar **sedative expectorant**, apparently from the excretion of the drug by the respiratory surfaces as well as specifically. It is given with great advantage in the first stage of acute bronchitis in strong subjects, in asthma, in hæmoptysis, and with special care at the commencement of acute pneumonia.

5. USES OF THE COMBINED ACTIONS OF ANTIMONY.

When the various effects of Antimony thus detailed are reviewed together, it is found to be a powerful general depressant, oxygenation being impaired, nervo-muscular activity reduced, the heart weakened, and the waste of the body increased through all the channels of excretion and by loss of heat. When a full dose (1 to 2 gr. of Tartarated Antimony) is given, and vomiting induced, this general depression may threaten to pass into collapse, with pallor and coldness of the surface, and marked fall of the body temperature. On this account it may sometimes be employed with benefit as an **antipyretic** or febrifuge at the commencement of acute febrile attacks in sound robust subjects, more especially in bronchitis, where the attendant increase of the bronchial secretion will be serviceable, and the possible emesis by no means contra-

indicated. Caution must be exercised in prescribing this powerful depressant, and the best method of administering it is in doses of $\frac{1}{16}$ to $\frac{1}{8}$ gr. in water every 15 or 30 minutes, or of $\frac{1}{4}$ to $\frac{1}{2}$ gr. every three hours, until the skin becomes moist and cool.

The unquestionable value of Plummer's Pill would appear to be partly referable in the same way to the action of Antimony not only on nutrition, but on the various organs of elimination, including the skin and the kidneys.

BISMUTHUM. Bismuth. Bi. 207·3.

All the salts and preparations of Bismuth are derived from the metal.

1. Bismuthi Carbonas.—Bismuth Oxycarbonate. $2(Bi_2O_2CO_3), H_2O$.

Source.—Made by the interaction of Bismuth Nitrate and Ammonium Carbonate $4(Bi3NO_3) + 4(N_3H_{11}C_2O_5) + 2H_2O = 2Bi_2O_2CO_3 + 6CO_2 + 12NH_4NO_3$.

Characters.—A heavy whitish powder; insoluble in water; soluble with effervescence in Nitric Acid. *Impurities.*—Nitrates, chlorides and sulphates; other metals, including selenium and tellurium. *Dose*, 5 to 20 gr.

Preparation.

Trochiscus Bismuthi Compositus.—2 gr. of Oxycarbonate, 4 gr. Precipitated Calcium Carbonate, 2 gr. Heavy Magnesium Carbonate, and the Rose Basis to form one lozenge.

2. Bismuthi Subnitras. — Bismuth Oxynitrate. $BiONO_3,H_2O$.

Source.— Prepared by the interaction of Bismuth Nitrate and Water. $Bi3NO_3 + H_2O = BiONO_3 + 2HNO_3$.

Characters.—A heavy white powder, inodorous, in minute crystalline scales; insoluble in water; very faintly acid. *Impurities*, as of the oxycarbonate. *Dose*, 5 to 20 gr.

Preparation.

Liquor Bismuthi et Ammonii Citratis.—"Liquor Bismuthi." Made by exactly dissolving the

Oxynitrate in diluted Nitric Acid; adding Potassium Citrate and Potassium Carbonate dissolved in Water; boiling; cooling; adding Solution of Ammonia to the moist precipitate to effect solution; diluting with Water, and filtering. 1 fl.dr. = about 3 gr. of Bismuth Oxide. *Dose*, ½ to 1 fl.dr.

From Bismuthi Subnitras is made:

Bismuthi Oxidum.—Bismuth Oxide. Bi_2O_3.

Source.—Made by boiling Bismuth Oxynitrate with Solution of Sodium Hydroxide. $2BiONO_3 + 2NaHO = Bi_2O_3 + 2NaNO_3 + H_2O$.

Characters.—A brownish-yellow powder. *Impurities*, as of the Oxycarbonate. *Dose*, 5 to 20 gr.

3. Bismuthi Salicylas.—Bismuth Salicylate. Bismuth Oxysalicylate. $C_6H_4 \cdot OH \cdot COO \cdot BiO$.

Source.—Prepared by the interaction of Bismuth Nitrate and Sodium Salicylate.

Characters.—A white or nearly white powder, amorphous. Insoluble in water. *Impurities:* as of Bismuth Oxycarbonate; free Salicylic Acid. *Dose*, 5 to 20 gr. in cachets.

GENERAL CHEMICAL CHARACTERS OF BISMUTH SALTS.

Solutions of the Nitrate or Chloride give a white precipitate when thrown into water; and this is blackened by H_2S.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, applied in the form of powder or ointment, Bismuth Oxynitrate acts only physically on the unbroken skin, protecting it from the irritation of air and dirt. If the surface be inflamed, as in chapped hands, chapped nipples, irritable ulcers and eczema, Bismuth is a mild **sedative and astringent**, soothing and drying up the part. Accessible mucous membranes, when in a condition of catarrh, are similarly affected by the drug: thus it is used with success as a "snuff" for nasal catarrh (combined with gum acacia and morphine); as a dusting powder in ophthalmic practice; as an injection in gonorrhœa and leucorrhœa; and in irritability of the cervix uteri as a pessary. Bismuth **is not** known to be absorbed from unbroken surfaces.

Internally, the local actions and uses of Bismuth Oxynitrate constitute all, or nearly all, that is definitely known respecting it as a remedy. In the *stomach* it is insoluble, and exerts the same **sedative and astringent** action as on the skin, whether by affecting the nerves and local circulation, or by its mechanical properties, that is, by coating and protecting the mucous surface. The Liquor Bismuthi et Ammonii Citratis is decomposed by the acid gastric juice, depositing oxychloride as a white precipitate. Little or no effect is to be expected from less than 20-gr. doses of the Oxynitrate for an adult, and these may be increased with perfect safety. Bismuth is extensively used in Great Britain in the treatment of pain and vomiting due to catarrh or structural disease of the stomach, such as the gastric catarrh that follows a surfeit of food or alcoholic excess, recurrent gastric ulcer and cancer; also in some cases of so-called nervous or reflex vomiting, as in pregnancy and hysteria, where a true catarrh is often present. The Oxycarbonate is given in such conditions, but is better combined, on the one hand, with alkalis, such as Sodium Bicarbonate, if there be much actual catarrh; or, on the other hand, with Opium if pain be the chief symptom. A combination of the Oxynitrate and Dover's Powder is almost a specific for the pain and vomiting of gastric ulcer and malignant disease.

The astringent and sedative influence of Bismuth on the *intestines* constitutes it a valuable remedy for diarrhœa in delicate persons, such as children, phthisical subjects, and those who have been exhausted by other causes. In lienteric diarrhœa, probably referable to duodenal catarrh, it is sometimes invaluable. But in the intestines, as in the stomach, it may have to be freely given (20 to 60 gr. of the Oxynitrate for a dose), whilst the addition of Opium, in however small quantity, greatly assists its action, and in persistent cases of diarrhœa may be absolutely necessary, the same combination with Dover's Powder giving excellent results. Bismuth Oxynitrate is partly converted into the sulphide in the bowels, which imparts a characteristic leaden-grey colour to the fæces. Bismuth Salicylate is a valuable intestinal disinfectant. See *Acidum Salicylicum*, page 389.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS AND USES, AND REMOTE LOCAL ACTIONS.

Neither the insoluble nor the soluble (but weak) preparations of Bismuth enter the blood in any quantity. Still, the metal has been detected, both here and in the tissues. Bismuth very slowly finds its way through all the organs; but

no specific effect can be attributed to the Oxynitrate, even when given in doses of several drachms. Soluble salts of Bismuth, however, produce fatty degeneration in animals, exactly like Arsenic and Phosphorus. Bismuth has been found in the urine and milk, but no use is made of its remote influence, if any such exist. The breath of patients taking Bismuth has occasionally an unpleasant odour somewhat like that of garlic, apparently due to an impurity in the drug.

GROUP III.

THE NON-METALLIC ELEMENTS.

The non-metallic elements of the Pharmacopœia fall for discussion into the following natural Sub-groups: 1. Chlorum, Iodum and Bromum; 2. Sulphur; and 3. Carbo. Phosphorus, which is pharmacologically allied with Arsenic, has been described under Group II.

Sub-Group 1.

Chlorum, Iodum, Bromum.

CHLORUM. Chlorine. Cl. 35·19.

Although not contained in the Pharmacopœia as the pure gas under its own name, Chlorine is officially obtained from two different sources, namely: (1) Chlorinated Lime; (2) Hydrochloric Acid.

1. **Calx Chlorinata.**—Chlorinated Lime. $CaCl_2O_2$, $CaCl_2$ or $CaOCl_2$. A compound of Calcium Hypochlorite and Calcium Chloride, or directly of Lime and Chlorine.

Source.—Made by passing Chlorine Gas over Slaked Lime until absorption ceases. $2CaH_2O_2 + 2Cl_2 = CaCl_2O_2,CaCl_2 + 2H_2O$.

Characters.—A dull white powder, with a characteristic odour. Becomes moist and decomposes on exposure to air. Partially soluble in water. Bleaches and disinfects. Contains 33 per cent. available Chlorine.

Impurity.—Deficiency in Chlorine, detected volumetrically with sodium thiosulphate.

Preparation.

Liquor Calcis Chlorinatæ.—1 in 10 of Water; mixed, agitated, and strained. Yields about 3 per cent. available Chlorine.

From Calx Chlorinata is made:

LIQUOR SODÆ CHLORINATÆ.—Solution of Chlorinated Soda. NaCl,NaClO.

Source.—Made by mixing a solution of Sodium Carbonate with Chlorinated Lime triturated in water; and filtering. $CaCl_2O_2,CaCl_2 + 2Na_2CO_3 = (NaCl,NaClO)_2 + 2CaCO_3$.

Characters.—A colourless liquid, with a feeble odour of Chlorine and an astringent taste; alkaline. A mixed solution of Sodium Hypochlorite and Sodium Chloride, with Sodium Carbonate. Yields 2·5 per cent. of available Chlorine. Bleaches indigo sulphate. *Dose*, 10 to 20 min.

Calx Chlorinata is also used in the preparation of Chloroform.

2. **Acidum Nitro-hydrochloricum Dilutum.**—Contains free Chlorine. *See* page 144.

GENERAL CHEMICAL CHARACTERS OF CHLORINE PREPARATIONS.

These yield the characteristic odour of Chlorine when warmed with HCl and MnO_2.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, the actions and uses of Chlorine depend upon the great affinity which it possesses for hydrogen, and its consequent power to decompose compounds in which hydrogen forms part of the molecule, such as ammonia, sulphuretted hydrogen, ammonium sulphide and water. The properties of the body on which it acts (chemical, vital, or both) are completely altered; whilst nascent oxygen is set free, and the Chlorine further combines with the remaining elements of the broken-down molecule. Thus it is a powerful **irritant** to the skin, causing redness, vesication, even sloughing, and coagulating the albuminates of the part. For the same reason, Chlorine is one of the most powerful of **disinfectants, deodorisers and decolorisers**, its activity as a disinfectant greatly exceeding that of Phenol, and in some respects even of Corrosive Sublimate. As a stimulant and disinfectant, Chlorine Water, or the Solutions of Chlorinated Lime or Chlorinated Soda, may be applied to foul ulcers, dissection and poisoned wounds, and diphtheritic surfaces; or used in

contagious ophthalmia, ozæna, and other foul discharges from surfaces or cavities.

Of much more extensive application is the disinfectant action of Chlorinated Lime and its preparations apart from the body: to purify rooms, wash infected clothes, flush drains, and throw upon the stools of typhoid fever and cholera before they are disposed of.

Internally, Chlorine exerts a similar local action upon the parts with which it comes in contact; and is employed as a wash or gargle, to disinfect and stimulate foul ulcers of the mouth, tongue, and throat, especially in diphtheria.

In the stomach Chlorine in dilute solutions becomes converted into hydrochloric acid and chlorides, and loses all further effect upon the body as the uncombined element. If any portion of a dose reached the intestine it might disinfect the contents.

2. Actions in the blood, specific actions, and remote local actions.

It is doubtful whether Chlorine enters the circulation or reaches the tissues uncombined; more probably it is entirely converted into chlorides. It has been given in typhus, typhoid fever, small-pox, and other "putrescent" diseases, but there is little evidence in favour of continuing its use in these cases. In chronic dysentery and liver disease of a malarial origin Diluted Nitro-hydrochloric Acid is a useful drug. The Chlorates in full doses may cause hæmaturia, purpura, and other symptoms of hæmolysis or toxæmia.

IODUM. Iodine. I. 125·9.

Under this head will be discussed both Iodine and the Iodides of Potassium and Sodium, the forms in which the element is generally administered internally. Reference will also be made to the other official Iodides.

Iodum.—Iodine. A solid non-metallic element.

Source.—Obtained from native iodides and iodates; and from kelp, the ashes of seaweeds.

Characters.—Rhombic prisms or octohedrons of the

trimetric system, of a dark colour and metallic lustre, and peculiar odour, which yield a violet-coloured vapour when heated. *Solubility.*—1 in 5,000 of water; freely in alcohol 90 per cent., chloroform, ether, or solution of potassium iodide. *Incompatibles.*—Ammonia, metallic salts, mineral acids, vegetable alkaloids. *Impurities.*—Iodine cyanide, subliming as colourless prisms; iron, not volatile; water, as moisture.

Preparations.

1. **Liquor Iodi Fortis.**—Strong Solution of Iodine. "Linimentum Iodi." Iodine, 5; Potassium Iodide, 3; Water, 5; Alcohol 90 per cent., 36. 1 in 10 nearly.

2. **Tinctura Iodi.**—Iodine, 1; Potassium Iodide, 1; Distilled Water, 1; Alcohol 90 per cent., up to 40. 1 in 40. *Dose*, 2 to 5 min. (diluted).

3. **Unguentum Iodi.**—Iodine, 1; Potassium Iodide, 1; Glycerin, 3; Lard, 20. 1 in 25.

From Iodum are made:

4. **Potassii Iodidum.**—Potassium Iodide. KI.

Source.—Obtained by (1) dissolving a slight excess of Iodine in a strong solution of Potassium Hydroxide, and evaporating to dryness; $6KOH + 3I_2 = 5KI + KIO_3 + 3H_2O$. (2) Mixing the residue with Charcoal and fusing, thus converting the iodate, which was formed with the iodide, into iodide: $2KIO_3 + 6C = 2KI + 6CO$. (3) Dissolving and purifying.

Characters.—Colourless, opaque, cubic crystals, with some odour of iodine, a saline taste, and feebly alkaline reaction. *Solubility.*—In less than its weight of water; 1 in 12 of alcohol 90 per cent. Strikes blue with preparations containing starch on addition of chlorine. *Chief Impurities.*—Iodates, detected by blue colour with tartaric acid and starch; bromides, cyanides, nitrates; many metals. *Dose*, 5 to 20 gr. (freely diluted, after meals).

Preparations.

a. Linimentum Potassii Iodidi cum Sapone.—Potassium Iodide, 3; Curd Soap, 4; Glycerin, 2; Oil of Lemon. ·25; Water, 20.

b. Unguentum Potassii Iodidi.—Potassium Iodide, 100; Potassium Carbonate, 6; Water, 94; Benzoated Lard, 800.

c. Also all the preparations of Iodum.

5. Sodii Iodidum.—Sodium Iodide. NaI.

Source.—Prepared like Potassium Iodide, Sodium Hydroxide being used in place of Potassium Hydroxide, and the salt crystallised at not less than 68° F.

Characters.—A dry, white, crystalline, deliquescent powder, with a saline and bitter taste. *Solubility.*—Readily soluble in less than its weight of water; 1 in 3 of alcohol 90 per cent. *Impurities*, as of Potassium Iodide. *Dose*, 5 to 20 gr.

Iodine is also used in the production of Iodoform, and of the Iodides of Arsenium, Ferrum, Hydrargyrum, Plumbum and Sulphur, or of preparations containing them.

GENERAL CHEMICAL CHARACTERS OF IODINE AND ITS SALTS.

Iodine is entirely volatilised by heat, with the evolution of violet vapours. Aqueous solutions strike a deep blue with starch. Solutions of Iodides give the same reaction when decomposed by solution of chlorine; also a yellow precipitate with $AgNO_3$, insoluble in HNO_3, soluble in NH_4HO. Solutions of Iodine may be decolorised by Sodium thiosulphate.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally applied, Iodine is a powerful **irritant and vesicant**, decomposing organic molecules, and entering into loose chemical combination with the albuminous constituents of the parts. At the same time it stains the epidermis a deep brown; causes considerable pain; and is absorbed into the blood, partly by the skin and partly by the air of respiration in the form of vapour. It is also a very powerful **antiseptic and disinfectant.**

The Tincture, Strong Solution, and Ointment of Iodine are extensively used as stimulants and disinfectants to foul callous ulcers, much like Silver Nitrate; as vegetable parasiticides in ringworm; and as counter-irritants in subacute or chronic inflammation of joints, periosteum, lymphatic glands, the pleura and the lungs, for which purpose the Ointments of Lead Iodide and of Mercuric Iodide are also applied. In these instances the chief effect is doubtless stimulation: but a certain amount of the Iodine is absorbed, and acts specifically, as will be presently described. Iodine in solution is injected into cysts, goitres, hydroceles, etc., with much success.

Potassium Iodide applied to the unbroken skin is neither irritant nor capable of being absorbed, unless it be decomposed by the sweat. It is readily taken up from exposed mucous membranes. How much specific value can be attached to the Liniment of Potassium Iodide with Soap is doubtful.

Internally, the local action of free Iodine is also irritant, and the Tincture is successfully applied to the gums in periosteal toothache. Inhaled into the respiratory passages, it gives rise to cough, sneezing, severe pain over the frontal sinuses, distressing pains in the chest and dyspnœa. Compounds of Iodine with Creosote and various soothing volatile substances, such as Chloroform and Ether, are used as continuous inhalations in the so-called "antiseptic" treatment of phthisis, bronchitis and other forms of chronic pulmonary disease.

In the stomach and bowels, although it is gradually converted into Sodium Iodide or Iodate, the irritant effects of free Iodine are continued, with abdominal pain, sickness and diarrhœa as the result; and therefore it is given internally in the form of an iodide. Small doses, however, of the Tincture (3 to 5 minims) in a fluid ounce of water, given every 15 minutes, will occasionally check vomiting from a variety of causes. Potassium Iodide is decomposed in the stomach, the sodium salt and albuminate being formed from it.

2. ACTIONS ON THE BLOOD.

Iodine is freely absorbed into the blood from the mucous surfaces, and the sodium Iodide quickly enters from the alimentary canal. In the blood the element is at first found combined with sodium; but this salt appears to be decomposed and the Iodine for a time set free, for some of the red corpuscles are broken down (if the amount of Iodine be large), and bloody effusions and bloody urine make their appearance. Such results are to be carefully avoided in practice; and as far as we know, less degrees of them cannot be usefully applied to therapeutical purposes, unless the tendency to coagulation be somewhat increased by it.

3. SPECIFIC ACTIONS AND USES.

The Iodide of sodium and albuminous compounds pass from the blood into the tissues with remarkable rapidity, and may be found in all of them, especially the excreting organs and lymphatic glands, whilst they appear very scantily in the nervous centres. According to Binz, the Iodine is liberated

in the tissues. Almost as quickly it again leaves the tissues; and in thus passing rapidly through the protoplasm of the body, and sharing in its metabolism by combining (probably very loosely) with the albuminous molecules, Iodine no doubt **accelerates tissue changes**. As no increase of urea accompanies this effect, nor bodily wasting, the Iodine must either spare the liver (which is the chief source of urea), or accelerate the metabolism of the plasma, rather than of the tissue elements themselves. (See *Metabolism*, Part IV., Chapter IX.) However this may be, the following are the principal directions in which Iodine affects nutrition, and the applications of the same:—

(1) The *lymphatic glands* are reduced in size by Iodine, which is extensively used for **scrofulous** and other chronic enlargements of the glands, whether applied locally as Iodine, or administered internally as the Iodides.

(2) Certain *poisons* which have intimately associated themselves with the albuminous structures, are disengaged from these combinations by Iodine. Lead and Mercury may be swept out of the tissues with the assistance of Potassium Iodide, administered for plumbism and hydrargyrism respectively.

(3) The principal application, however, of iodine is in the treatment of **syphilis**. Either the virus of this disease is thus eliminated from the system, or Iodine hastens the life and disappearance of the small-celled growth by which syphilis is characterised. It is specially valuable in the tertiary forms of syphilis, when Mercury cannot always be given with advantage; and nodes and other superficial enlargements, gummata in the viscera, and certain forms of skin disease may be very successfully treated with the Potassium salt. The same precautions must be observed with respect to the general health, and especially the preservation of digestion, in a course of Iodine, as are laid down under the head of Mercury (page 106).

(4) In subacute and **chronic inflammations** of various kinds, such as exudations or effusions in connection with the joints and serous cavities, and some forms of pulmonary consolidation, Potassium Iodide may promote absorption by stimulating the local nutrition or possibly the protoplasm of the vessel-walls. The local application of Iodine "paint" is combined in such cases.

(5) *Scrofula* is benefited by Iodine, especially when it affects the lymphatic glands, enlargements of which are treated with the Strong Solution or the Ointment of Lead Iodide; with interstitial injections (rarely); internally with

Ferrous Iodide, or Iodine mineral waters, such as the water of Woodhall. On the contrary, phthisis is rarely benefited by Iodides, unless there be a syphilitic taint present.

(6) In chronic *rheumatism* where debility is not a prominent symptom, in gonorrhœal rheumatism, and in the arthritis of syphilis, the Iodides may be beneficial.

Binz holds that free Iodine and its readily decomposable compounds are narcotic, paralysing the cerebral centres by direct action on the nervous structures, and finally proving fatal through the respiratory centre. The heart, vessels, and body temperature are unaffected by Iodine; and the depressing effect on these of large doses of Potassium Iodide is believed to be caused by the Potassium. At the same time, this salt is of great value in certain morbid conditions of the heart and arteries, particularly those associated with high blood-pressure. The remarkably useful effect of Potassium Iodide in relieving or remedying **aneurysm** is due to the reduction of the blood pressure by the alkali, the coagulating effect of Iodine on the blood, and the specific effect of Iodine on the chronic inflammatory changes (often syphilitic) in the wall of the artery which have led to the dilatation.

4. Remote Local Actions and Uses.

Iodine is rapidly excreted, appearing in the urine, the mucous secretions generally (specially in those of the air-passages), the perspiration, saliva, bile and milk. Part of the sodium salt which reaches the excreting organs is thrown out unchanged, but part is decomposed and the Iodine again set free to exert its local action remotely.

The diuretic effect of Potassium Iodide is not marked unless large doses be given, and probably depends upon the alkali, not on the Iodine. The latter may, however, have an action upon the nutrition of the kidney, and the Iodide may therefore be used in some forms of chronic Bright's disease, combined with other remedies.

The excretion of Iodine by the mucous membrane of the respiratory tract is of most interest to the therapeutist. In certain subjects, and probably when Potassium Iodide contains free Iodine as an impurity, its exhibition produces a series of unpleasant symptoms known as "iodism," consisting of coryza, the watery discharge from the nose being sometimes profuse; sneezing; severe pain of a bursting character over the frontal sinuses, commonly called "headache;" swelling and redness of the gums, hard and soft palates and fauces; foulness of the tongue, and increase of the mucus of the mouth; cough and frothy expectoration, and a sense

of heat and rawness in the trachea and chest. The phenomena of irritation of the respiratory mucosa by the out-going Iodine are therefore identical with those produced by the immediate action of Iodine by inhalation, but in a minor degree. In bronchial catarrh, when the secretion is deficient, the mucous membrane of the bronchi swollen and dry, and cough useless and painful, Potassium Iodide is a valuable **expectorant**, quickly inducing a flow of thin mucus, by establishing secretion, or by liquefying tenacious mucus which may be plugging or irritating the bronchi. It is, further, a powerful indirect **antispasmodic**, given with great benefit in asthma and emphysema. Ethyl Iodide (not official) inhaled as vapour may rapidly relieve the spasm of asthma. Potassium Iodide is sometimes given in other respiratory diseases, *e.g.* pneumonia, if the consolidation threaten to persist.

In escaping by the skin the liberated Iodine produces in certain individuals peculiar **eruptions**: papular, acneiform, vesicular or pustular, rarely purpuric. The value of the drug in certain skin diseases no doubt depends partly on this influence. Potassium Iodide is said to be an **antigalactagogue**.

5. Actions and Uses of the Several Preparations Containing Iodine.

1. *Ferri Iodidum.*—Syrupus Ferri Iodidi combines the actions of the two important elements, and is especially indicated and extensively employed when Iodine has to be administered for a length of time to anæmic subjects. This is the form in which Iodine is usually given in scrofula; it is a favourite remedy for strumous children.

2. *Hydrargyri Iodidum Rubrum* possesses chiefly the action of the Mercuric salts, and is used accordingly. See *Hydrargyrum*, page 105.

3. *Sulphuris Iodidum* is now used externally only, and is believed to produce the combined effects of the two drugs.

BROMUM. Bromine. Br. 79·35.

In connection with Bromine will be discussed Diluted Hydrobromic Acid and the three official Bromides of Ammonium, Potassium and Sodium.

1. Potassii Bromidum. — Potassium Bromide. KBr.

Source.—Obtained from Bromine, a strong solution of Potassium Hydroxide, and Charcoal, by a similar process to that by which the Potassium Iodide is made. *See* page 126.

Characters.—Colourless cubical crystals, without odour, of a pungent saline taste. *Solubility.*—1 in 2 of water; 1 in 2 of alcohol 90 per cent. *Impurities.*—Those of the iodide; thiocyanates. *Dose*, 5 to 30 gr.

From Potassium Bromide is made:

Acidum Hydrobromicum Dilutum.—Diluted Hydrobromic Acid. An aqueous solution containing 10 per cent. by weight of Hydrogen Bromide, HBr.

Source.—May be obtained by distilling Potassium Bromide with concentrated Phosphoric Acid.

Characters.—A colourless liquid, inodorous, with a strongly acid taste and acid reaction. Sp. gr., 1·077. It yields Bromine when heated with MnO_2 and H_2SO_4. *Impurities.*—Arsenium, barium, chlorides, phosphates, sulphates, sulphites. *Dose*, 15 to 60 min.

From Diluted Hydrobromic Acid is made:

Ammonii Bromidum.—Ammonium Bromide. NH_4Br.

Source.—Is formed by neutralising Hydrobromic Acid with solution of Ammonia. $HBr + NH_4HO = NH_4Br + H_2O$.

Characters.—Small colourless crystals, which become slightly yellow by exposure to the air, and have a pungent saline taste. *Solubility.*—Readily in water; less soluble in alcohol 90 per cent. Sublimes by heat. *Impurities.*—Lead, iron, iodides, bromates, nitrates. *Dose*, 5 to 30 gr.

2. Sodii Bromidum.—Sodium Bromide. NaBr.

Source.—May be prepared as Potassium Bromide, substituting Sodium Hydroxide for Potassium Hydroxide.

Characters.—Small white cubic crystals, somewhat deliquescent, inodorous, with saline taste. *Solubility.*—1 in less than 2 of water; 1 in 16 of alcohol 90 per cent. *Impurities*, as of Potassium Bromide. *Dose*, 5 to 30 gr.

General Chemical Characters of Bromine and its Salts.

Bromine gives a yellow colour with starch paste; a brown solution in CS_2. Bromides give a yellowish-white precipitate with $AgNO_3$; sparingly soluble in NH_4HO.

Actions and Uses.

1. Immediate Local Actions and Uses.

Externally Bromine is a powerful **irritant** and **escharotic.** Its local use is confined to the treatment of cancer of the cervix uteri (1 in 5 parts of rectified spirit). The Bromides have no such irritant action unless in highly concentrated solution. They are not absorbed from the unbroken skin.

Internally, the local action of free Bromine resembles that of Chlorine, the vapour being intensely irritant, and, indeed, irrespirable. It is never used in this way. The Bromides, applied in strong solution to the throat, or taken continuously for a time in full doses, are said to reduce the sensibility of the fauces, so that the reflex movements of the parts, such as swallowing, vomiting and cough, are not easily excited. They have therefore been employed previous to examinations or operations on the larynx, but Cocaine has now quite displaced them for this purpose. The Bromides have but little effect of an irritant kind on the stomach or bowels, so that large doses (20 grains thrice a day for years) may be readily borne. Particular care should be taken, however, to preserve digestion and regularity of the bowels in cases where Bromides are continuously prescribed.

2. Actions in the Blood.

Bromide of Potassium, the salt most commonly employed, is rapidly absorbed from all the mucous surfaces, enters the blood unchanged, but is probably at once converted into the sodium salt by double decomposition with sodium chloride. For a moment Bromine may be set free in the blood, but no special action or therapeutic application can be referred to this circumstance.

3. Specific Actions and Uses.

The Bromides appear to pass through the body as sodium Bromide. On the different organs they produce definite specific actions, which, speaking broadly, are of a depressant character.

The *nervous system* is specially affected. **Loss of reflex excitability** in connection with all the sentient surfaces of the body follows the administration of full medicinal doses. This result is due partly to depression of the peripheral (sensory) nervous filaments, but chiefly to reduced activity of the nervous centres in the brain and cord. At the same time the motor nerves are also soothed, and the *muscular* power (which we may conveniently consider along with the nervous), is much weakened. The phenomena of this general nervo-muscular depression are as follows, beginning with the highest centres:—

The Bromides lessen cerebral activity, readiness to react to emotional stimuli, and sensibility and irritability of mind generally, thus inducing a condition of brain favourable to the advent of sleep. They are thus indirect **hypnotics**, not acting like Opium and Chloral Hydrate, but so reducing the patient's sensibility of his surroundings, bodily condition or circumstances, as to prevent distraction and allow natural sleep to supervene. It is uncertain whether the Bromides act upon the nerve cells directly, or upon the cerebral blood-vessels. The soothing and hypnotic effects of the Bromides are very extensively employed in restlessness and sleeplessness from mental strain, whether emotional or intellectual, in the acute specific fevers when similar symptoms are urgent, in acute alcoholism, and in mania. In the last three conditions a certain amount of Chloral Hydrate or Opium may be advantageously combined with the Bromides. The most important application of the soothing action of the Bromides is in **epilepsy**, which is now almost exclusively treated with these salts, unless they be contra-indicated. Hysteria, infantile convulsions, whooping cough, general "nervousness," hypochondriasis, gastric and intestinal disorders of reflex origin, sea-sickness, and the irritable, excitable condition so common in women with uterine irregularities, are also relieved by Bromides, although not with the success obtained in epilepsy.

The great vital centres of the *medulla* are depressed by Bromides. Respiration becomes weakened and slower, whence possibly part of the value of the drug in whooping cough. **The heart is also slowed and weakened** in its action: chiefly however, by depression of its nervo-muscular substance, not of the cardiac centre. Bromides are of much service, therefore, in nervous disorders of the heart, especially in hysterical, dyspeptic and alcoholic subjects. The direct effect of these drugs on the vessels is unsettled; as a whole the tension is reduced.

The spinal centres and spinal nerves and the muscles are all depressed by the Bromides, the former so much so that the convulsions of Strychnine poisoning cannot be induced, and the two drugs are so far physiological antagonists. In such a case, and in tetanus, the Bromides might be given, but they are neither rapid nor powerful enough to be trusted to.

The temperature is lowered by Bromides, but not to an extent of much practical value.

The ovarian and uterine functions are quieted, and menorrhagia is relieved, by these drugs.

4. REMOTE LOCAL ACTIONS AND USES.

The Bromides appear in the secretions within a few minutes after their administration, being eliminated by the kidneys chiefly, by the salivary glands, mammæ, skin and all mucous surfaces. In passing through the excreting organs, the Bromides break up and Bromine is set free, which exerts a second stimulant effect on the parts. The urinary constituents are irregularly disturbed; but not in a manner that can be turned to therapeutical account. Infants at the breast may be affected by Bromine in the milk. The **skin** is markedly disturbed, a characteristic acne-like **eruption** appearing, or other forms of cutaneous disease, which are familiar in epileptics consuming large quantities of the drug. Cough is occasionally set up, and conjunctivitis may also occur. The interest to the practical therapeutist of these remote effects of Bromine is two-fold. First, they are somewhat protracted, elimination being less rapid than absorption and the drug accumulating in the system, so that a patient can be kept under its influence continuously. Secondly, in cases where the drug has to be steadily taken for an indefinite time, the unpleasant effects on the skin may sometimes be prevented by combining the Bromide with Arsenic.

Hydrobromic Acid possesses many of the properties of the Bromides, but is much less useful than Potassium Bromide. It is said to prevent the cerebral symptoms produced by Quinine, which it readily dissolves, and the after-effects of Morphine, if given with these drugs.

SUB-GROUP 2.

SULPHUR. SULPHUR. S. 31·82.

Under this head will be discussed not only Sulphur, but the official Sulphides, the form in which the element is chiefly active physiologically. Sulphur is found native as virgin sulphur and as sulphides of metals. It is the source of all the preparations, with the exception of Calx Sulphurata.

1. Sulphur Sublimatum.—Sublimed Sulphur Flowers of Sulphur.

Source.—Prepared more or less directly from native sulphur or sulphides.

Characters.—A fine, greenish-yellow gritty powder, without taste or odour; neutral. Entirely volatilised by heat. *Solubility.*—Insoluble in water; soluble in carbon bisulphide, fixed oils, and turpentine, with heat. *Impurities.*—Sulphurous and Sulphuric Acids; Arsenium Sulphide. *Dose*, 20 to 60 gr.

Preparations.

a. **Confectio Sulphuris.**—Sublimed Sulphur, 100; Acid Potassium Tartrate, 25; Tragacanth, 1; Syrup, 50; Tincture of Orange, 12·5; Glycerin, 37·5, *Dose*, 60 to 120 gr.

b. **Unguentum Sulphuris.**—1; Benzoated Lard, 9.

From Sulphur Sublimatum are made:

c. **Sulphur Præcipitatum.**—Precipitated Sulphur. Milk of Sulphur.

Source.—Made by (1) boiling Sublimed Sulphur and Lime in Water; (2) precipitating the filtrate with diluted Hydrochloric Acid, washing and drying. (1) $12S + 3CaH_2O_2 = 2CaS_5 + CaS_2O_3 + 3H_2O$. (2) $2CaS_5 + CaS_2O_3 + 6HCl = 3CaCl_2 + 6S_2 + 3H_2O$.

Characters.—A greyish-yellow soft powder. *Impurities.*—Calcium Sulphate, H_2SO_4 being used instead of HCl; detected by grittiness, and microscopically as crystals. H_2S; detected by odour. *Dose*, 20 to 60 gr.

Preparation.

TROCHISCUS SULPHURIS.—5; Acid Potassium Tartrate, 1; Refined Sugar, 8; Gum Acacia, 1; Tincture of Orange, 1; Mucilage of Gum Acacia, 1.

d. **Potassa Sulphurata.**—"Liver of Sulphur." A mixture of Salts of Potassium of which the chief are Potassium Sulphides.

Source.—Made by fusing Sublimed Sulphur with Potassium Carbonate.

Characters.—Solid greenish fragments, liver-brown when recently broken; alkaline; acrid to the taste; readily forming with water a yellow solution smelling of H_2S, which is evolved on addition of HCl. About 50 per cent. of the Sulphurated Potash should be soluble in alcohol 90 per cent.

e. **Sulphuris Iodidum.**—Sulphur Iodide. SI.

Source.—Made by fusing 1 of Sublimed Sulphur with 4 of Iodine.

Characters. — Greyish-black crystalline pieces, smelling strongly of Iodine. *Solubility.*—1 in 60 of glycerin; insoluble in cold water.

Preparation.

Unguentum Sulphuris Iodidi. — 1; Glycerin, 1; Benzoated Lard, 23.

Sublimed Sulphur is also contained in Pulvis Glycyrrhizæ Compositus (1 in 12); *and is used in preparing* Emplastrum Hydrargyri, Emplastrum Ammoniaci cum Hydrargyro, and Antimonium Sulphuratum.

2. Calx Sulphurata.—Sulphurated Lime. A mixture containing not much less than 50 per cent. of Calcium Sulphide, with Calcium Sulphate and Carbon.

Source.—May be made by heating a mixture of native Calcium Sulphate and Carbon.

Characters.—A greyish-white powder, smelling of sulphuretted hydrogen. *Dose*, $\frac{1}{4}$ to 1 gr. (in pill.)

General Chemical Characters of Sulphur.

Sulphur burns with a blue flame. Most Sulphides evolve H_2S with HCl.

Actions and Uses.

1. Immediate Local Actions and Uses.

Externally applied, Sulphur has but little local action of itself, but by contact with the acid products of the skin is partly converted into sulphuretted hydrogen and sulphides, which are energetic substances. Whether, therefore, it be rubbed on as the Ointment, worn in flannel, distributed over

the surface by fumigation, or given as a natural or artificial bath of "sulphur waters," it is not Sulphur, but its hydrogen compound, which possesses local therapeutical properties.

Sulphuretted hydrogen, when brought in contact with the skin in any of the forms just mentioned, is a **vascular stimulant and nervous sedative**. It is probably on this account that Sulphur has long been regarded as useful for relieving the pains of chronic rheumatism, and in certain kinds of skin disease, such as acne. The solution of the gas (in the form of baths) is also absorbed by the skin, and is extolled in chronic poisoning with lead and mercury, in syphilis, and in chronic enlargements of joints. The *rationale* of these effects will be presently discussed.

Sulphur and Sulphurated Potash and Lime destroy the *Acarus scabiei*, and are used in the treatment of itch. Sulphur Iodide is a local stimulant. See *Iodum*, page 127.

Internally, Sulphur has been locally applied to the throat in diphtheria, but with uncertain results. In the stomach it remains unaltered; and it passes as such into the intestines, where a small portion becomes converted into Sulphides and acts as a purgative, possibly by increasing peristalsis, more probably by stimulating the glandular structures. Milk of Sulphur, the Confection, the Lozenge and the Compound Powder of Liquorice are simple **laxatives**, producing an easy soft stool, with little or no pain. Sulphur Waters, drunk freely at Harrogate and Strathpeffer in Great Britain, at Aix-la-Chapelle, Challes, Aix-les-Bains and the Pyrenees on the Continent of Europe, and at the Blue Lick, Alpena, Sharon and other springs in the United States, have a similar but more powerful effect, producing considerable disturbance of the bowels, and depressing the portal circulation. Sulphur and Sulphur Waters are extensively used as purgatives in congestion of the rectum and liver, hæmorrhoids, and other diseases of the great bowel; and the waters and baths combined are powerful evacuants in plethora, hepatic engorgement, gravel, and disorders originating in connection with them.

Sulphur in some measure escapes unabsorbed in the fæces, partly unchanged, partly as sulphides of hydrogen and the alkalis which it has encountered in the bowel, the activity of purgation varying indirectly with the extent of absorption.

2. ACTIONS ON THE BLOOD.

The amount of Sulphur which enters the blood in the

form of sulphides of hydrogen and the alkalis, under the use of Sulphur or Sulphur Waters, produces no obvious effect upon it. When *inhaled* into the circulation, sulphuretted hydrogen is a powerful blood-poison, acting on both the red corpuscles and the plasma. It reduces the oxyhæmoglobin of the former, and decomposes the carbonates and phosphates of the latter, with the production of sulphides, sulphites and sulphates ; but this subject is not of therapeutical interest.

3. SPECIFIC ACTIONS AND USES.

The hydrogen and alkaline sulphides pass into the tissues from the blood, and act chiefly upon the central nervous system. When in large quantity, they induce rapid failure of the nervous centres, especially those of respiration and circulation, the subject dying rather of asphyxia than from the poisonous influence on the blood just described. It is possible that the headache and nervous depression which attend the use of Sulphur Waters in some persons are minor degrees of these effects. It is possible also that Sulphur and its compounds, possessing these powerful influences on the blood and tissues (which appear to be of the nature of arrest of oxydation), may modify nutrition to some extent even in medicinal doses. In chronic rheumatism, syphilis, gout and skin diseases they have been much prescribed from time immemorial, especially at watering-places. Sulphurated Lime has been found useful in scrofulous disease of bones, and in influencing suppuration.

4. REMOTE LOCAL ACTIONS AND USES.

It is under this head that we find the principal suggestions for the therapeutical employment of Sulphur. The sulphides which we have traced through the blood and tissues are variously excreted. By the kidneys Sulphur passes out as sulphates, and it is said that one-half of a dose of Sulphur Præcipitatum can be thus recovered from the urine, but only one-fifth of Sulphur Sublimatum. If it be in excess, part is excreted as sulphides. No special use is made of these facts. By the skin it escapes as sulphides, giving the characteristic foul odour to the perspiration, and somewhat increasing its amount. Sulphur is used as a **mild cutaneous stimulant** and **diaphoretic,** and has always been regarded as a valuable internal remedy for many skin diseases, such as acne, chronic eczema, psoriasis and syphilitic eruptions. Drinking the waters and taking the

baths at Sulphur springs probably act in this remote local way. Calx Sulphurata is specially useful in boils. The sulphides are also excreted by the bronchi and lungs, giving their odour to the breath; and Sulphur was once much used as an **expectorant**, especially in chronic bronchitis with abundant expectoration and gouty or rheumatic associations.

The valuable effect of Sulphur waters, taken internally and used as baths, in cases of chronic rheumatism, gout, skin disease, plethora, etc., is principally, if not entirely, to be accounted for by the immediate and remote local actions of the Sulphides on the bowels and portal system, and on the kidneys, skin and bronchi, respectively.

The actions and uses of burned Sulphur as a disinfectant depend on the Sulphurous anhydride which is evolved. They are described at page 151.

SUB-GROUP 3.

CARBO. CARBON. C. 11·91.

Carbon as such is official in the form of Wood Charcoal.

Carbo Ligni.—Wood Charcoal.

Source.—The carbonaceous residue of wood charred by exposure to a red heat without access of air.

Characters.—A black powder, without taste or odour, free from gritty matter. When burned at a high temperature with free access of air it leaves not more than 7·5 per cent. of ash. *Dose*, 60 to 120 gr.

From Charcoal is made:

Carbonis Bisulphidum.—Carbon Bisulphide. CS_2.

Source.—May be prepared by the combination of Carbon and Sulphur at a high temperature, the product being subsequently condensed and purified.

Characters.—A clear, colourless, highly refractive liquid; odour characteristic. Sp. gr., 1·268. *Soluble* in alcohol, ether, chloroform, and fixed and volatile oils; very slightly in water. Highly inflammable; rapidly evaporating at ordinary temperatures. *Impurities.*—S and H_2S.

ACTIONS AND USES.

Externally. — Charcoal absorbs and condenses many gaseous bodies and vapours, as oxygen, carbonic acid, etc.; and attracts and oxydises the colouring, odoriferous and sapid principles of many liquid substances, for example, litmus, bitters, wines and decomposing fluids. It has been used as a valuable decoloriser, and as a **deodorant** and **oxydising agent** to absorb the foul emanations from cancerous and other discharges, ulcers and wounds, being either hung around the bed in bags, or directly applied.

Internally.—Charcoal is locally used as a dentifrice. When taken into the stomach in sufficient bulk, either pure or in the form of biscuits, it absorbs any gas and acrid products of indigestion which may cause distension and distress, and is useful as a **carminative** in some forms of flatulent dyspepsia. Charcoal has been recommended by Sir Alfred Garrod as an **antidote** in poisoning with opium, nux vomica, aconite and other organic poisons, the alkaloids of which, as well as toxines, it attracts in the stomach and renders inert. In the intestines it may possibly reduce flatulence, **disinfect** the fæces, and thus diminish the reflex peristaltic movements and relieve diarrhœa. It is probable, indeed, that this absorbent action of Charcoal can be retained in the bowel, or even in the stomach, after it has been thoroughly brought in contact with water.

Charcoal is entirely evacuated by the bowel and is not absorbed, so that it exerts no *specific* action on the body.

Carbon Bisulphide is used as a solvent in pharmacy.

GROUP IV.

ACIDS.

The official Acids may be classified as follows :—

1. **Inorganic Acids.**—Sulphuric, Nitric, Hydrochloric, Nitro-hydrochloric, Phosphoric, Boric, Chromic, Hydrobromic and Sulphurous. Of these, Hydrobromic Acid is described under *Bromum*, page 132. Arsenious "Acid" is an anhydride, not a true acid. *See* page 109.

2. **Organic Acids.**—Acetic, Citric, Tartaric, Lactic, Hydrocyanic Diluted, Carbolic, Benzoic, Gallic and Tannic, Oleic and Salicylic. Of the Organic Acids, the first four only will be discussed here ; the actions and uses of the other substances being but little connected with their properties as acids.

Acidum Sulphuricum, Nitricum, Hydrochloricum, Nitro-hydrochloricum Dilutum, Phosphoricum Concentratum, Aceticum, Citricum, and Tartaricum.

These substances are conveniently considered together. They all possess distinctly acid properties ; that is, they neutralise alkalis and turn blue litmus red.

Acidum Sulphuricum.—Sulphuric Acid. H_2SO_4, Hydrogen Sulphate, 98 per cent. by weight, in Water.

Source —Obtained by the combustion of Sulphur or

pyrites, and the oxydation by nitrous fumes, and hydration by aqueous vapour, of the resulting sulphurous anhydride.

Characters.—A colourless, corrosive, oily-looking, intensely acid liquid. Sp. gr. 1·843. Soluble Sulphates give a heavy white insoluble precipitate with $BaCl_2$. *Impurities.*—Nitric and other acids; selenium, ammonium, iron, copper, lead, arsenium and carbonaceous matter.

Preparations.

1. **Acidum Sulphuricum Dilutum.**—Diluted Sulphuric Acid. 1 to fully 11 of Distilled Water. Contains 13·65 per cent. of H_2SO_4. Sp. gr. 1·094. *Dose*, 5 to 20 min.

From Acidum Sulphuricum Dilutum is prepared:

Infusum Rosæ Acidum.—1 to 80. *See* page 284.

2. **Acidum Sulphuricum Aromaticum.**—Aromatic Sulphuric Acid. "Elixir of Vitriol." Prepared by mixing Sulphuric Acid, 3; Alcohol (90 per cent.), 29·5; Spirit of Cinnamon, ·5; Tincture of Ginger, 10. Contains 13·8 per cent. of H_2SO_4. Sp. gr. ·922 to ·926. *Dose*, 5 to 20 min.

From Acidum Sulphuricum Aromaticum is prepared:

Infusum Cinchonæ Acidum.—1 to 80. *See* page 311.

3. Many Sulphates and other preparations.

Acidum Nitricum.—Nitric Acid. HNO_3, Hydrogen Nitrate, 20 per cent. by weight, in Water.

Source.—Prepared by the interaction of Potassium or Sodium Nitrate with Sulphuric Acid.

Characters.—A clear, colourless, intensely acid liquid emitting corrosive fumes. Sp. gr. 1·42. If a solution of a Nitrate be added to H_2SO_4 at the bottom of a test-tube, and solution of $FeSO_4$ carefully added after cooling, a black-brown ring will be formed at the line of junction of the first two fluids. *Impurities.* — Sulphates, bromates, iodates; chlorides; lead, copper, arsenium, iron.

Preparations.

1. **Acidum Nitricum Dilutum.**—Diluted Nitric Acid. 1 to fully 4 of Distilled Water. Contains 17·44 per cent. of HNO_3. Sp. gr. 1·101. *Dose*, 5 to 20 min.

2. **Acidum Nitro-hydrochloricum Dilutum.**—Diluted Nitro-hydrochloric Acid. 3; with Hydrochloric Acid, 4; and Distilled Water, 25. To be made fourteen days before using. It contains free chlorine, and hydrochloric, nitric and nitrous acids, dissolved in water. Sp. gr. 1·07. *Dose*, 5 to 20 min.

3. Many Nitrates and other preparations.

Acidum Hydrochloricum.—Hydrochloric Acid. Hydrogen Chloride, HCl, 31·79 per cent. by weight, dissolved in Water.

Source.—Obtained by the interaction of Sulphuric Acid and Sodium Chloride, and solution of the fumes in Water.

Characters.—A colourless, strongly acid liquid, emitting white pungent fumes. Sp. gr. 1·160. Chlorides give a white curdy precipitate with $AgNO_3$, soluble in NH_4HO; insoluble in HNO_3. *Impurities.*—Sulphuric and sulphurous acids, arsenium, lead, copper, iron, aluminium, bromides and iodides; free chlorine.

Preparations.

1. **Acidum Hydrochloricum Dilutum.**—Diluted Hydrochloric Acid. 1 to fully 2·3 of Distilled Water. Contains 10·58 per cent. of HCl. Sp. gr 1·052. *Dose*, 5 to 20 min.

2. **Acidum Nitro-hydrochloricum Dilutum.**—*See Acidum Nitricum*, page 143.

3. **Glycerinum Pepsini.**—*See Pepsinum*, page 431.

4. Many Chlorides and other preparations.

Acidum Phosphoricum Concentratum.—Concentrated Phosphoric Acid. Hydrogen Orthophosphate, H_3PO_4, with 33·7 per cent. of Water.

Source.—May be made by treating with Nitric Acid and Water the residue left after burning Phosphorus in air.

Characters.—A colourless syrupy liquid, with an acid taste and reaction. Sp. gr. 1·5. Phosphates give a yellow precipitate with $AgNO_3$, soluble in NH_4HO and in HNO_3. *Impurities.*—Arsenium, lead, copper and other metals; silica; sulphuric, nitric, hydrochloric, phosphorous and pyro- and meta-phosphoric acids. *Incompatibles.*—Calcium salts; sodium carbonate.

Preparation.

Acidum Phosphoricum Dilutum.—Diluted Phosphoric Acid. 1 to 5·6 of Distilled Water. Contains 13·8 per cent. of H_3PO_4. Sp. gr. 1·08. *Dose*, 5 to 20 min.

Concentrated Phosphoric Acid is used in preparing Syrupus Calcii Lactophosphatis, Syrupus Ferri Phosphatis, Syrupus Ferri Phosphatis cum Quinina et Strychnina, and Acidum Hydrobromicum Dilutum.

Acidum Aceticum. — Acetic Acid. Hydrogen Acetate, CH_3COOH, 33 per cent. by weight, in Water.

Source.—Prepared from Wood by destructive distillation or by the oxydation of Ethylic Alcohol.

Characters.—A clear, colourless liquid, with a pungent odour and strong acid reaction. Sp. gr. 1·044. Acetates evolve odour of acetic acid on addition of H_2SO_4. *Impurities.*—Lead, copper, arsenium; nitric, formic, sulphuric, hydrochloric and sulphurous acids.

Preparations.

1. **Acidum Aceticum Dilutum.** — Diluted Acetic Acid. 1 to 7 of Distilled Water. Contains 4·27 per cent. of Hydrogen Acetate. Sp. gr. 1·006. *Dose*, 30 to 120 min.

Diluted Acetic Acid is used in preparing:

Acetum Ipecacuanhæ, Acetum Scillæ and Liquor Morphinæ Acetatis.

2. **Oxymel.**—5; Water, 5; Clarified Honey liquefied, 40. *Dose*, 1 to 2 fl.dr.

3. **Oxymel Scillæ.**—*See Scilla*, page 412.

4. Many Acetates.

Acidum Aceticum Glaciale. — Glacial Acetic Acid. Hydrogen Acetate, $CH_3{\cdot}COOH$, 99 per cent., with Water.

Characters.—A clear, colourless acid liquid, with a very pungent odour. Crystallises below 60° F. Sp. gr. 1·058. *Impurities.*—As of Acetic Acid.

Glacial Acetic Acid is used in preparing:

Acetum Cantharidis, Liquor Ferri Acetatis, and Linimentum Terebinthinæ Aceticum.

Acetum (*non-official*).—Vinegar. Contains 5·41 per cent. of Hydrogen Acetate, $CH_3{\cdot}COOH$.

Source.—Prepared from a mixture of malt and unmalted grain by the acetous fermentation. A little Sulphuric Acid is added to make it keep.

Characters.—A brown-coloured acid liquid, with a characteristic odour. Sp. gr. 1·017 to 1·019. *Impurity.*—Excess of sulphuric acid, detected volumetrically. *Dose*, 1 fl.dr. to 1 fl.oz.

Acidum Citricum.—Citric Acid. Hydrogen Citrate. $C_3H_4{\cdot}OH{\cdot}(COOH)_3,H_2O$.

Source.—Obtained from the juice of the fruit of various species of Citrus.

Characters.—Large colourless prisms of the trimetric system, with an acid taste. *Solubility.*—4 in 3 of cold, 2 in 1 of boiling, water; less soluble in alcohol 90 per cent.; slightly soluble in Ether. Soluble Citrates give a white precipitate when boiled with Lime-Water; no precipitate with $KC_2H_3O_2$. 20 gr. in ½ fl.oz. of water make a solution resembling lemon juice in strength and acidity; and neutralise 28·5 gr. of Potassii Bicarbonas, 24 gr. of Sodii Bicarbonas, or 15 gr. of Ammonii Carbonas. *Impurities.*—Lead, copper, iron, calcium, sulphuric acid, mineral matters; tartaric acid, detected by precipitate with potassium acetate. *Dose*, 5 to 20 gr.

Citric Acid is contained in or used in preparing:

Liquor Ammonii Citratis, Lithii Citras Effervescens, Succus Limonis, Syrupus Limonis, Sodii Phosphas Effervescens, Sodii Sulphas Effervescens, Magnesii Sulphas Effervescens; all these contain free Citric Acid. Also Potassii Citras, Ferri et Ammonii Citras, and Ferri et Quininæ Citras.

Acidum Tartaricum.—Tartaric Acid. Dextrorotatory Hydrogen Tartrate, $C_4H_6O_6$ or $\begin{matrix} CH{\cdot}OH{\cdot}COOH \\ | \\ CH{\cdot}OH{\cdot}COOH \end{matrix}$.

Source.—Prepared from Acid Potassium Tartrate.

Characters.—Colourless monoclinic prisms, with a strongly acid taste. *Solubility.*—Readily soluble in less than its own weight of water, and in less than 3 of alcohol 90 per cent. An excess gives with KHO a white crystalline precipitate. Soluble Tartrates give a white precipitate with excess of Lime Water. 20 gr. neutralise 26⅔ gr. of Potassii Bicarbonas, 22½ gr. of Sodii Bicarbonas, or 14 gr. of Ammonii Carbonas. *Impurities.*—Copper, arsenium, iron, calcium, potassium, sodium, lead; oxalic acid, mineral matter. *Dose*, 5 to 20 gr.

Tartaric Acid is used in preparing:

The various Effervescing Salts, and Pilula Quininæ Sulphatis.

Carbonic Acid.—Although not official as such, Carbonic Acid Gas is extensively used in medicine, being obtained from Bicarbonates and Carbonates, commonly of Sodium, Potassium, or Ammonium, by decomposition with Citric or Tartaric Acid. The process is known as *effervescence*, and the reaction may be thus represented:

$$3KHCO_3 + H_3C_6H_5O_7 = K_3C_6H_5O_7 + 3CO_2 + 3H_2O.$$

Potassii Bicarbonas + Acidum Citricum = Potassii Citras + Carbonic Acid Gas + Water.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Acids are irritants, and some of them are very powerful corrosives. The strong acids are used as **caustics**: Nitric Acid to destroy chancres; Acetic Acid, warts; Sulphuric Acid, some forms of malignant growths. Very dilute watery solutions, sponged on the skin in fever, cool the surface by evaporation, and thus act as **refrigerants**; whilst watery solutions of Sulphuric Acid used in this way appear to constringe the tissues, and diminish the sweating of phthisis. Carbonic Acid baths have a stimulant action on the skin; and are employed at Nauheim, or as artificially prepared, in the treatment of some kinds of cardiac disease.

Internally.—In the dilute form, acids act directly upon the contents of the alimentary canal, and are used as **antidotes** in the treatment of poisoning by alkalis. In every instance the free acids quickly unite with bases in the digestive tract, and form neutral salts. In the mouth they are **stimulants and sialagogues**: they rouse the appetite, and aid digestion by increasing the flow of saliva, and thus indirectly, as well as reflexly, the secretion of gastric juice. Acids also relieve thirst; Citric, Tartaric and Acetic Acids, Carbonic Acid in effervescence, and the mineral acids largely diluted with water, being chiefly used for this purpose in fever, as well as acid wines, drinks and fruits in great variety. In the stomach Hydrochloric Acid directly augments the acidity of the gastric juice, and is given in dyspepsia, during or after meals, as a **digestive adjuvant.** Carbonic Acid, introduced in effervescing wines and waters, has a grateful stimulant action upon the gastric nerves; and in the forms of champagne and effervescing mixtures is a most valuable remedy in the treatment of sickness with exhaustion. Reaching the duodenum, acids **increase the acidity of the chyme and stimulate the liver, pancreas and intestinal muscles and glands.** Diluted

Nitric and Nitro-hydrochloric Acids, given at the end of meals, are therefore used as **cholagogues** in intestinal dyspepsia with hepatic torpidity, especially tropical cases. Sulphuric Acid, as the Diluted or the Aromatic Acid, is a powerful **intestinal astringent**, much employed in diarrhœa.

2. ACTIONS ON THE BLOOD, AND THEIR USES.

Acids **render the blood less alkaline** (but never acid, even in poisonous doses), by combining with part of the alkali of the liquor sanguinis. No special use is made of this property. Phosphoric Acid increases the phosphates in the red corpuscles, and is thus **hæmatinic**. The vegetable acids, when given as salts of the alkalis, have an important **deoxydising** effect on the blood. For example, Potassium Citrate becomes converted in the blood into Potassium Carbonate, Carbonic Acid and water; a portion, however, of the Citric Acid always remaining unoxydised (see *Potassium*, p. 39), thus: $2(C_3H_4 \cdot OH(COOK)_3) + O_{18}$ (in blood) $= 3(K_2CO_3) + 5H_2O + 9CO_2$. Citrates, Tartrates and Acetates of Potassium, Sodium, Ammonium, etc., as such or in the effervescing form, may therefore be used to set free in the blood the carbonates of the alkalis, which cannot be so conveniently or so safely given in large doses by the stomach. The vegetable acids have been used in the treatment of scurvy, but with doubtful success; and in rheumatism, with equally questionable results beyond their action on the mouth, skin and kidneys.

3. SPECIFIC ACTIONS AND USES.

In the tissues and organs, acids diminish the normal conversion of ammonia into urea, whilst each exhibits specific actions of its own. *Sulphuric Acid* is a vascular **astringent** and used in hæmorrhage. *Nitric* and *Nitro-hydrochloric Acids* are believed to be **cholagogue**, when given internally or as a footbath (8 fl. oz. to one gallon of water), or a compress wrung out of the solution and worn over the hepatic region. Tropical enlargements of the liver may thus be reduced. *Hydrochloric Acid* enters the tissues as chlorides; and no further specific action or use is to be credited to the small doses which can be given of it. *Phosphoric Acid* also possesses no further influence on the tissues than that of increasing *pro tanto* the amount of phosphates, and possibly the growth of bone; and its value in constitutional diseases is probably due to its action on the red corpuscles, and to the bases with which it is combined (Iron, Calcium, etc.). The **tonic** influence of acids is most probably referable to their stimulating

effect upon the digestive, biliary and metabolic functions. As we have seen, *Acetic*, *Citric* and *Tartaric Acids* never reach the tissues, being decomposed in the blood, unless they be given in large doses.

4. REMOTE LOCAL ACTIONS AND USES.

The acids, having chiefly entered into combination as neutral salts, or having been decomposed in the blood, produce remarkably little local action when they are escaping from the body in the secretions. Thus *Sulphuric Acid* is excreted chiefly by the kidneys, increasing very slightly the normal amount of sulphates; part probably escapes by the bowels as sodium and magnesium sulphates; part possibly by the skin, this acid being an **anhidrotic** in night-sweating. *Phosphoric* and *Hydrochloric Acids* behave similarly. *Nitric Acid* is believed to stimulate the formation of ammonia, and thus actually to diminish slightly the acidity of the urine. Salts of *Acetic*, *Tartaric* and *Citric Acids* are excreted as carbonates; given in excess these acids escape unchanged by the kidneys and skin. Another point to be noted about all these acids, therefore, is that they **do not increase the free acidity of the urine in any considerable or useful degree.** It must be observed, however, that all the acids probably stimulate the kidneys and skin indirectly by increasing the total amount of salts excreted.

Acidum Boricum.—Boric Acid. H_3BO_3. Boracic Acid.

Source.—Made by the interaction of Sulphuric Acid and Borax; and by the purification of native Boric Acid.

Characters.—Colourless pearly, lamellar crystals, unctuous to the touch, odourless, with a slightly acid and bitter taste. A weak acid. *Solubility.*—1 in 30 of cold, 1 in 3 of boiling, water; 1 in 4 of glycerin; 1 in 30 of alcohol 90 per cent. A solution in alcohol burns with a green flame. *Dose*, 5 to 15 gr.

Preparations.

1. **Glycerinum Acidi Borici.**—6; Glycerin, to make 20; heated together to 302° F.

2. **Unguentum Acidi Borici.** — 1; Paraffin Ointment, white, 9.

Borax.—Borax. Biborate of Sodium. Sodium Pyroborate. $Na_2B_4O_7,10H_2O$.

Source.—Native. Also made by neutralising native Boric Acid with Sodium Carbonate; or by boiling native Calcium Borate with a solution of Sodium Carbonate.

Characters.—Transparent colourless crystals, sometimes slightly effloresced, weakly alkaline. *Solubility.*—1 in 25 of cold, 2 in 1 of boiling, water; 1 in 1 of glycerin; insoluble in alcohol 90 per cent. *Dose*, 5 to 20 gr.

Preparations.

1. **Glycerinum Boracis.**—1; Glycerin, 6; triturated.

2. **Mel Boracis.**—2; Glycerin, 1; Clarified Honey, 16; mixed.

ACTIONS AND USES.

Externally, Boric Acid destroys low organisms, a solution of 1 in 800 preventing the development of anthrax bacilli. It is thus a valuable **antiseptic and disinfectant**. On the tissues it produces little or no irritation, and is therefore peculiarly adapted for use as a surgical dressing and for ophthalmic and aural practice. Boric Acid lint, lotions, warm fomentations made from a boiling saturated solution, and the Ointment are now in very frequent use as applications to burns, wounds and ulcers; and a weak solution of the Acid (2 to 3 per cent.) with Glycerin is employed to wash out the bladder. Boric Acid is also the favourite daily disinfectant for the rectum in cases where nutrient enemata have to be given for a length of time. As its action does not extend beyond the surface to which it is applied, Boric Acid is never used for dressing cavities. In the form of a powder, the Ointment, or the Glycerin, it relieves itching, particularly pruritus vulvæ et ani, and as a dusting-powder it prevents the fœtor of perspiration.

Internally, Boric Acid is a gastro-intestinal irritant in large doses. It is rapidly absorbed into the blood, and reaching the tissues appears to possess a sedative action on the nervous system, as Borax occasionally proves useful in epilepsy after other measures, including Bromides, have failed.

Boric Acid is eliminated in most of the secretions, particularly by the kidneys, where it **acidulates and disinfects the**

urine, and is therefore given in inflammatory affections of the genito-urinary tract, alone or in combination with Benzoic Acid.

The action of Borax is very similar to that of the Acid. As the Glycerinum or Mel, it is a mild but efficient disinfectant in aphthous states of the mouth; and as a lotion in some kinds of parasitic and itching skin disease.

Acidum Sulphurosum.—Sulphurous Acid. An aqueous solution containing 6·4 per cent. of Hydrogen Sulphite, H_2SO_3, corresponding to 5 per cent. by weight of Sulphurous Anhydride, SO_2.

Source.—Made by boiling Sulphuric Acid with Carbon, Mercury or Copper, and dissolving the gas in Water; or by burning Sulphur in air or oxygen.

Characters.—A colourless liquid, with a pungent sulphurous odour. Sp. gr. 1·025. Sulphites destroy the colour of solutions of $KMnO_4$; and evolve SO_2 with H_2SO_4. *Impurities.*—Sulphuric acid; mineral matters; excess of water, detected by volumetric starch and iodine test. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

From Acidum Sulphurosum is made:

Sodii Sulphis.—Sodium Sulphite. Na_2SO_3, $7H_2O$.

Source.—Obtained by the interaction of Sulphurous Acid and Sodium Carbonate.

Characters.—Colourless, transparent, monoclinic, efflorescent prisms; inodorous; with a sulphurous and saline taste; neutral or feebly alkaline. *Solubility.*—Readily in water, very sparingly in alcohol 90 per cent. *Dose*, 5 to 20 gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Sulphurous Acid is a powerful **deoxydising** agent. Seizing on oxygen and water, it decomposes organic bodies, and at the same time produces upon them the **irritant** local effects of sulphuric acid, into which it is converted. It thus destroys low forms of living matter, including the organisms associated with fermentation, decomposition and certain diseases, 1 part in 2000 of water being sufficient to kill some kinds of bacteria, and much weaker solutions to prevent their development. Sulphurous Acid is therefore applied to ringworm and

to foul wounds; and some kinds of sore throat are relieved by a spray of the official Acid. Morbid fermentation in the stomach, attended by the growth of organisms, such as *torula* and *sarcina*, may be quickly arrested by the official Acid; but the Sodium salt is a more convenient form for internal use, being decomposed by the acid of the gastric juice. Given in full doses, Sulphites become converted into sulphates, and act as purgatives.

2. ACTIONS ON THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

Sulphites were once supposed to enter the blood and tissues, and to arrest morbid fermentation or fever processes within them. The evidence, however, is to the effect that Sulphites are not absorbed as such, but as sulphates, and are excreted as such by the kidneys and bowels. The benefit derived from them in fevers is therefore probably due to the laxative and diuretic effects of the higher salt.

Dry Sulphurous Anhydride, although not official, is very extensively used for fumigating infected rooms and clothing, being probably the most powerful, most certain and most convenient of all **disinfectants.** Sulphur is burned on a shovel or plate, the outlets from the room having been carefully closed, excepting the door through which retreat is made.

Acidum Chromicum.—Chromic Anhydride. CrO_3. "Chromic Acid."

Source.—Produced by the interaction of Sulphuric Acid and Potassium Bichromate.

Characters. — Crimson needles, very deliquescent; inodorous; corrosive to the skin. *Soluble* very readily in water and in ether. May explode with glycerin, ether, or alcohol 90 per cent. Mixed with cold alcohol, aldehyde is evolved, and a green residue of chromium oxide remains. *Impurity.*—Sulphuric Acid.

Preparation.

Liquor Acidi Chromici.—1 to 3 of Water. Contains 29·5 per cent. H_2CrO_4. Sp. gr. 1·185.

ACTIONS AND USES.

Chromic Acid is a powerfully oxydising body. It thus

destroys the organisms and products of decomposition, and is an active **deodorant** and **disinfectant,** which may be used (½ gr. to one fluid ounce of water) to wash foul or infected parts. An 8 per cent. solution is efficacious in sweating feet. Chromic Acid is also a strong **caustic**; and may be applied as a paste with water or as the Solution, to condylomata, warts and syphilitic sores; or in weak solution (1 in 40) to ulcers of the tongue and mouth, and in pharyngeal and laryngeal affections. Care must be taken to limit its action to the diseased part, as it has a great power of penetrating the tissues.

Acidum Nitrosum.—Nitrous Acid. HNO_2. (*Not official as such.*)

This acid is not itself used in medicine, but the Nitrites are active and valuable drugs. Those in use are Sodium Nitrite, Amyl Nitrite, and Ethyl Nitrite, as well as Spirit of Nitrous Ether. The Sodium salt will be noticed here; the others under their own heads at pages 188 and 179.

Sodii Nitris.—Sodium Nitrite. $NaNO_2$.

Source.—Obtained by fusing Sodium Nitrate with metallic Lead. $2NaNO_3 + 2Pb = 2NaNO_2 + 2PbO$.

Characters.—A white crystalline, deliquescent powder. Very *soluble* in water; the solution neutral or slightly alkaline. *Dose*, 1 to 2 gr.

ACTIONS AND USES.

Sodium Nitrite acts upon the blood, the heart and the vessels **like Amyl Nitrite,** only less suddenly and powerfully and for a longer period of time. (*See* page 188.) Its depressant action on the central nervous system is more marked than that of the Amyl compound; and it paralyses the peripheral nerves and the muscles not only in this way, but through the blood. It is used in cardiac disease characterised by recurrent attacks of pain.

Acidum Lacticum.—Lactic Acid. A liquid containing 75 per cent. of Hydrogen Lactate, $CH_3{\cdot}CHOH{\cdot}COOH$, with 25 per cent. of Water.

Source.—May be produced by the fermentation of Lactose.

Characters.—A colourless, hygroscopic, syrupy liquid, inodorous, with very sour taste and acid reaction. Sp. gr. 1·21. Miscible in all proportions with water, alcohol 90 per cent., and ether; nearly insoluble in chloroform. *Impurities.*—Mineral and other acids, sugars, gum, glycerin, organic and inorganic matters, and metals.

Acidum Lacticum is employed in the preparation of Syrupus Calcii Lactophosphatis.

ACTIONS AND USES.

Lactic Acid is of much physiological interest as a normal constituent of the gastric juice, and a product of muscular metabolism. Its medicinal action cannot, however, be turned to much therapeutical use. The Acid has been used with very uncertain results as a spray in croup and diphtheria, to dissolve the membrane, and to promote repair in tuberculous ulceration of the pharynx and larynx—50 to 100 per cent. aqueous solutions—with more benefit. Internally, it may be given as a **digestive adjuvant** after meals in dyspepsia. Entering the blood as alkaline lactates, it is decomposed into carbonic acid; is excreted as such in the urine; and has been credited with a beneficial effect in catarrh of the bladder. It has also been given in diabetes mellitus.

GROUP V.

WATER AND HYDROGEN PEROXIDE.

Aqua Destillata.—H_2O. Pure Water, prepared by distillation from good natural potable water.

Distilled Water is used in preparing medicines of every kind.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, natural Water acts chiefly as a means of applying heat or cold to the surface of the body, being readily obtained at any temperature that may be desired. To produce this effect, Water may be applied in the form of **baths** of all kinds: cold, cool, temperate, tepid, warm, hot, vapour- or variously medicated; also by sponging, douching, fomenting, etc. These subjects are noticed in the fourth part of the work (*see* page 610). Possessing these properties, Water is used externally for cleansing purposes; for either raising or lowering the temperature of the body; relieving pain, insomnia and delirium; removing spasms or convulsions; diminishing the circulation in deep parts by superficial "derivation," as in congestion of the brain; etc. Water is also used, in a purely local way, as a wash or dressing to wounds; as the basis of warm fomentations in inflammations; and as a **hæmostatic** (30° to 50° F., and 110° to 120° F.). *See* page 552.

Internally, Water is constantly being taken in the form of food and drink. It relieves thirst; improves digestion and intestinal action when drunk in moderation and at proper times; and in a physical way may reduce the local or general temperature, *e.g.* as ice slowly sucked in sore throat and febrile conditions. *Hot* Water is a **gastric sedative**. *Warm* Water is an **emetic**.

2. ACTIONS ON THE BLOOD.

Water is quickly incorporated with the circulating plasma. Injections of normal saline (·9 per cent. NaCl in sterilised Water) raise the blood pressure, and prevent or remove collapse.

3. SPECIFIC ACTIONS AND USES.

Water plays an essential part in tissue life and in the

activity of all the organs. A copious supply increases nutrition up to a certain point, especially the deposit of fat, and is extensively employed in hydrotherapeutics.

4. REMOTE LOCAL ACTIONS AND USES.

Water is excreted by the kidneys, skin, lungs, bowels—indeed, necessarily in every secretion. Increase of Water in the urine is most readily induced when the skin is kept cool; and it carries with it an excess of urea, phosphoric acid and sodium chloride. Water is thus a **diuretic**, and in one sense the most natural measure of the kind; it is indicated in the form either of Distilled Water (as such or aërated) or of the waters of certain spas, when we desire simply to irrigate or flush the uriniferous tubules and urinary passages, and wash from them the products of disease, such as blood, leucocytes, cellular *débris*, sediments and small calculi (*see* pages 594–596). Possibly some kinds of renal and other calculi may be dissolved by the steady consumption of Distilled Water, which carries away minute traces of the stones, whilst it prevents fresh accretion on the surface.

As a **diaphoretic** Water acts, on the one hand, when hot, or, on the other hand, when sipped cold in association with external heat. It is the basis of most of our domestic measures for relieving feverishness by inducing perspiration, such as warm drinks of all kinds and spirituous compounds.

Liquor Hydrogenii Peroxidi.—Solution of Hydrogen Peroxide. An aqueous solution of Hydrogen Peroxide, H_2O_2.

Source.—Prepared by the interaction of Water, Barium Peroxide and a dilute mineral acid, at a temperature below 50° F.

Characters.—A colourless odourless liquid, with a slightly acid taste; it renders the saliva frothy. Decomposed by heat into $H_2O + O$. *Impurities, etc.*—Barium, mineral matters; deficiency in H_2O_2. *Dose*, ½ to 2 fl.dr.

ACTIONS AND USES.

Hydrogen Peroxide is a powerfully **oxydising agent**, possessing decolorising and **disinfectant** properties. It is chiefly used to cleanse the skin, as a local disinfectant to septic surfaces, and as a general disinfectant in the sickroom. It also has been recommended for internal administration in a variety of affections, but with uncertain results.

GROUP VI.

THE CARBON COMPOUNDS.

ALCOHOL.

1. Alcohol Absolutum.—Absolute Alcohol. Ethyl Hydroxide. C_2H_5OH, with not more than 1 per cent. by weight of water.

Source.—Obtained by the removal of water from less strong Ethylic Alcohol, and subsequent distillation.

Characters.—Colourless, very volatile and hygroscopic at common temperatures. Sp. gr. ·7940 to ·7969. Gives a green colour with K_2CrO_4, CrO_3 and H_2SO_4, a sweetish odour being evolved. *Impurities.*—Resins or oils; detected by turbidity on dilution. Excess of water, giving blue colour with anhydrous copper sulphate; fixed matter; fusel oil and its allies, amylic alcohol, aldehyde; tannic acid, and other organic substances.

Alcohol Absolutum is used in preparing Liquor Ethyl Nitritis and Liquor Sodii Ethylatis.

2. Spiritus Rectificatus.—Alcohol 90 per cent. Rectified Spirit. A liquid containing 90 parts by volume of Ethyl Hydroxide, C_2H_5OH, and 10 parts by volume of Water.

Source.—Obtained by distillation of fermented saccharine liquids. $C_6H_{12}O_6$ (Grape Sugar) $= 2C_2H_5OH + 2CO_2$.

Characters.—Colourless, transparent, very mobile, with a pleasant odour and strong spirituous burning taste. Sp. gr. 0·834. Burns with a smokeless blue flame. *Impurities.*—Water; tested volumetrically; amylic alcohol, beyond a trace, detected by excessive reduction of $AgNO_3$; aldehyde; resins or oils, giving turbidity on dilution with water; fixed matters; and tannic acid.

Preparations.

a. **Alcohol (70 per cent.).**—Made by mixing 100 fl.oz. of Alcohol 90 per cent. with 31·05 fl.oz. of Distilled Water. Sp. gr. 0·8900.

b. **Alcohol (60 per cent.).** — Made by mixing 100 fl.oz. of Alcohol (90 per cent.) with 53·65 fl.oz. of Distilled Water. Sp. gr. 0·9135.

c. **Alcohol (45 per cent.).** — Made by mixing 100 fl.oz. of Alcohol (90 per cent.) with 105·34 fl.oz. of Distilled Water. Sp. gr. 0·9436.

d. **Alcohol (20 per cent.).** — Made by mixing 100 fl.oz. of Alcohol (90 per cent.) with 355·8 fl.oz. of Distilled Water. Sp. gr. 0·9760.

Rectified Spirit and the Diluted Alcohols are used in preparing Chloroform, many Tinctures, Spirits, Liniments and other preparations.

3. **Spiritus Vini Gallici.**—Brandy. A spirituous liquid distilled from wine and matured by age.

Characters and Composition.—A spirit of a light sherry colour, and peculiar flavour. Contains not less than 36·5 per cent. by weight, or 43·5 per cent. by volume, of *Ethyl Hydroxide*, with some *ethylic ether* combined with *acetic* and other *ethers*, and traces of *volatile oils*.

Preparation.

Mistura Spiritus Vini Gallici.—Mixture of Brandy. "Egg Flip." Brandy and Cinnamon Water, of each 4 fl.oz.; two Yolks of Eggs; Refined Sugar, ½ oz. *Dose*, 1 to 2 fl.oz.

4. **Vinum Xericum.**—Sherry. A Spanish Wine.

Characters and Composition.—Pale yellowish-brown. Contains not less than 16 per cent. by volume of *Ethyl Hydroxide, colouring matter, ethers, acid potassium tartrate, malates, sugar, etc. Impurity.*—Salicylic acid.

Sherry is used in preparing:

the following Vina: Antimoniale, Colchici, Ferri, Ipecacuanhæ.

Vinum Aurantii is made by fermentation of a saccharine solution; Vinum Ferri Citratis and Vinum Quininæ are made from Vinum Aurantii.

Amount of Alcohol in various important substances containing it.

Alcohol Absolutum, 99 per cent.
Alcohol (U.S.P.), 94 per cent.

Spiritus Rectificatus, 90 per cent.
Alcohol Dilutum (U.S.P.), 64·5 per cent.
Spiritus Vini Gallici (Brandy), about 36·5 per cent.
Spiritus Frumenti (Whisky), about 51 to 59 per cent.
Rum, Gin, Strong Liqueurs } about 51 to 59 per cent.
Port, Sherry, and Madeira, about 16 to 22 per cent.
Vinum Album Fortius (U.S.P.), 23 to 29 per cent.
Vinum Album (U.S.P.) about 12 to 14 per cent.
Champagne, about 10 to 13 per cent.
Vinum Aurantii, 10 to 12 per cent.
Hock and Burgundy, about 9 to 12 per cent.
Claret, 8 to 12 per cent.
Ale and Porter, about 3, 5, or more per cent.
Cider, 5 to 9 per cent.
Kumiss (made from milk), about 1 to 3 per cent.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, Alcohol is an **antiseptic and disinfectant,** employed as a constituent of lotions for ulcers and wounds. In the form of Brandy it is rubbed into the skin to prevent bed-sores, by hardening and disinfecting the epidermis, Applied in lotion to the skin, with free evaporation allowed, Alcohol is a powerful **refrigerant,** withdrawing heat from the body by its evaporation, blanching the parts by vascular constriction, and producing a sense of cold. In this form it is used to prevent or allay inflammations of superficial parts, such as the subcutaneous tissues, joints and muscles ; and to relieve pain, especially headache, due to vascular dilatation and throbbing. Alcoholic lotions sponged on the skin also diminish the activity of the sweat glands, and may be used in excessive perspiration as an anhidrotic. On the contrary, if the vapour be confined and allowed to act upon the tissues underneath, or if the Alcohol be rubbed into the part, it penetrates and hardens the epithelium, and irritates the nerves and vessels of the cutaneous structures, causing redness, heat and pain, followed by local anæsthesia. Alcoholic liniments containing soaps, essential oils, and other **stimulants** (*e.g.* Linimentum Camphoræ and Linimentum Camphoræ Ammoniatum), are applied with friction to increase the nutrition of parts which are the seat of chronic inflammation, induration, adhesions, stiffness and pain, such as the fibrous

structures and muscles in chronic rheumatism, periostitis and paralysis; or to produce a **rubefacient** effect on a large area of skin—of the surface of the chest, for instance, in bronchitis. Alcohol is absorbed by the unbroken skin.

Internally, the local action of Alcohol begins in the *mouth* with its characteristic taste, and a hot, painful, stimulating effect on the tongue and mucous membrane. If it be retained in contact with them, the epithelium becomes condensed and whitened, and the parts beneath are anæsthetised. Some forms of toothache can thus be quickly and completely relieved, the Spirit also acting as a disinfectant in the pulp cavity. Wines and other wholesome alcoholic liquids, consumed during meals, have an action of the first importance on the nerves of the tongue, palate and nose. By virtue of their taste, flavour and bouquet they **give a relish to food, increase the appetite, and stimulate the flow of saliva and the functions of the stomach.**

In the *stomach* the action of Alcohol is complex, and of great importance. (1) Alcohol mixes with the *contents* of the stomach; is partly decomposed into aldehyde and acetic acid; and precipitates some of the pepsin, and some of the peptones, proteoses and proteids: so far it depresses digestion. (2) It stimulates the *mucous membrane*, dilating and filling the vessels with blood; excites and markedly increases the flow of gastric juice; sharpens the appetite; and renders the movements of the viscus more energetic: in these respects it greatly assists digestion. The total effect of a moderate dose of Alcohol is decidedly to **favour gastric digestion,** especially in cases where the nerves, vessels and glands lack vigour, as in old age and in the chronic dyspepsia of persons weakened by acute illness, town life and anxious sedentary employments. Herein consists the value of a small amount of wine or wholesome ale taken with meat meals by such subjects. The danger lies in excess, which readily destroys the activity of the juice, contracts the blood-vessels, and sets up a secretion of alkaline mucus which greatly interferes with digestion, a common cause of acute and chronic dyspepsia.

(3) The action of Alcohol on the gastric wall produces extensive effects of a *reflex* kind. The heart is stimulated by moderate doses, producing a pleasurable rise of blood-pressure and a sense of power. The vessels dilate universally, filling the active organs with blood, which further increases their activity, the brain being specially excited and the skin flushed and warmed subjectively. If the quantity be large, these salutary effects of Alcohol as a **diffusible stimulant** may pass into depression; and the sudden ingestion of a large amount

of spirit may prove rapidly fatal by shock. The reflex effects of alcoholic stimulants, if properly applied, add to their value at meal-times, by increasing the enjoyment of eating, and thus the digestive power. Certain forms of pain in the stomach and bowels are rapidly relieved by the local action of Brandy, which also helps to expel flatus and check diarrhœa; and pain, spasms, irregular or feeble action of the heart, cold feelings of the surface, and low conditions of the brain, are all quickly removed by the same reflex means before the Alcohol could be absorbed in quantity into the blood.

2. Actions on the Blood.

Alcohol enters the blood unchanged, or partly as aldehyde, and is distributed by it to the tissues and organs, a small part only becoming lost in it as acetic and carbonic acid. The actions of Alcohol on the corpuscles are still obscure, but it probably **binds the oxygen more firmly to the hæmoglobin**, so that oxygenation of the tissues occurs less freely, and therefore less extensively. The effect of this upon metabolism will now be described.

3. Specific Actions.

Alcohol is rapidly taken up by the various organs, chiefly unchanged. If given in moderate quantity, it is (1) oxydised in its passage through the tissues into carbonic acid and water like other carbohydrates, that is, it is a **food**, or source of heat and vital energy. At the same time it produces two other equally important effects; for (2) it **reduces the activity of metabolism** or the oxydation of the tissues; and (3) it first **stimulates** and afterwards depresses the circulatory and nervous systems, quite independently of its action on tissue change. These three effects of Alcohol must be discussed separately.

(1) *Alcohol as a food.*—It may now be accepted as proved that, when taken in sufficiently small quantities, **Alcohol is oxydised in the tissues**; and that it only passes out of the body unchanged, through the lungs, kidneys, etc., when so freely given that excretion occurs before oxydation has had time to take place. This decomposition of Alcohol must necessarily develop vital force and heat, like the oxydation of sugar, fat and albumen. Alcohol belongs to that class of foods which do not become an integral part of the living cells, as does much of the albumen, salts, etc., but remain in the plasma which bathes the cells, are oxydised there, and constitute their pabulum, the materials which supply the

active elements with much of their energy. Thus it happens that Alcohol can for a time sustain life when no food (so-called) is taken, as in confirmed drunkards and in some cases of severe illness. Professor Binz, of Bonn, who has studied this question with great industry and success, has calculated how much energy is contained in a gramme of Alcohol, and finds that two ounces of Absolute Alcohol yield about the same amount of warmth to the body as is supplied by an ounce and a half of Cod-liver Oil. The *uses* of Alcohol as a food will be presently described along with its other applications.

(2) *Alcohol as a nutritive depressant.*—Whilst it is itself thus oxydised in the tissues, **Alcohol unquestionably interferes with the metabolism or oxydation of other substances,** especially (it would appear) saving or sparing the wear and tear of the "tissue proteids," or formed protoplasm of the cells. This has been determined from three facts observed in animals supplied with moderate doses of Alcohol: first, that less oxygen is absorbed; secondly, that the temperature falls, and the albuminous tissues, whilst they do not waste, tend to degenerate into fat, so that the body as a whole grows fat and gross; thirdly, and chiefly, that the amount of urea, uric acid, carbonic acid and salts excreted is decidedly diminished. These are settled facts; the explanation of them is more difficult. The interference of Alcohol with the oxygenating function of the red corpuscle is one obvious cause of impaired metabolism; another is the extreme readiness of the Alcohol when it reaches the tissues to seize upon the oxygen which is there, thus robbing as it were the fixed elements of their necessary share, and arresting their decomposition at the middle stage of fat. This remarkable property of Alcohol of **saving tissue waste** is one of the foundations of its employment in fever, to be presently discussed.

(3) *Alcohol as a stimulant and narcotic.*—The *circulation* in every part of the body is stimulated by a moderate dose of Alcohol. The increase in the force and frequency of the heart, and the dilatation of the peripheral blood-vessels, which together constitute this **increased circulatory activity,** are both so far reflex effects from the mucous membrane of the stomach, as we have already seen; but they are also in part direct, the Alcohol affecting the nervo-muscular structures of the heart, the cardiac centre, possibly the vaso-dilator centres in the medulla and cord, and certainly the nervo-muscular tissue of the middle coat of the vessels. To these causes of circulatory excitement must be added the voluntary muscular movements, which are much exaggerated under the

influence of Alcohol. When Alcohol is taken in large quantities, its stimulant effect on the circulation passes into depression, both reflex and direct; and death may result, in part at least, from cardiac failure.

Upon the *nervous system* the first effect of Alcohol in moderate quantity is also one of stimulation. The **nervous centres are increased in vigour** from the highest to the lowest, and in the same order of sequence. The imagination becomes brilliant, the feelings are exalted, the intellect is cleared, the senses become more acute, the feeling of bodily strength and ability is raised, and some of the appetites are temporarily excited. The centres of speech, and of muscular movements generally, are specially stimulated, giving rise to animated talk and lively gesticulations; and, therewith, a sense of *bien être*, referable to the combined nervous and circulatory excitement, spreads over the system.

If the dose of Alcohol be larger, these phenomena of stimulation are at first more pronounced, but very soon give place to **depression**, which spreads, like the excitement, from the highest to the lowest centres of the brain and cord. The intellectual, emotional, and voluntary faculties become first inco-ordinated, then dull, and finally completely arrested; the muscles are first **ataxic** and next paralysed, so that after an unsteady, staggering gait the erect posture is impossible; and the consequent depression of the respiratory and circulatory centres leads to stertorous breathing, circulatory failure, and even death. The effects of Alcohol upon the nervous centres are referable partly to dilatation of the blood-vessels of the brain and cord, but certainly also to a direct action of the drug upon the nerve cells.

The action of Alcohol on the other bodily functions is chiefly, if not entirely, indirect. Thus, the *muscles* are affected solely through the nervous centres and nerves. *Respiration* is first increased, then slowed and weakened, partly through the special centre, but manifestly also, to a great extent, through the muscles and the circulation. Death occurs partly by asphyxia. **The bodily temperature is, on the whole, lowered** by Alcohol: (1) by increased circulation through the dilated peripheral vessels; (2) by increased perspiration; (3) by diminished metabolism; and (4) after large non-medicinal doses, by general depression. The sense of warmth is, on the contrary, increased by the flushing of the skin with blood; a condition which promotes bodily heat and comfort in a warm or moderately cool atmosphere, but causes rapid refrigeration, general vital depression and possibly death in low states of the external temperature.

4. SPECIFIC USES.

The uses to which the complex specific actions of Alcohol may be turned are many, and of great importance.

Alcohol is employed in **fever**, and other acute wasting diseases, such as delirium tremens and acute mania. The therapeutical indications in these conditions are to prevent or to make good the great waste of tissues associated with the disease; to sustain the heart and nervous system, which threaten to fail, as the frequent pulse and the delirium testify; and to promote the loss of heat, which is being formed in excess, as evidenced by the thermometer, the dry brown tongue, the sleeplessness and the general restlessness of the patient. We have seen that these ends are all fulfilled to a certain extent by Alcohol. When the symptoms just mentioned appear, Brandy or other form of alcohol, and Wines of the strongest varieties, are given in a definite amount per diem, according to the height of the fever, the state of the pulse and cardiac sounds, the general strength, the ability to consume food, and the previous habits and age of the patient. It must be distinctly understood, however, that Alcohol is by no means essential in every case of fever; the very opposite being the fact. In delirium tremens (acute alcoholism), where food, in the ordinary sense of the word, can often be given with the greatest difficulty only, the very substance which, as a stimulant, has caused the disease may be judiciously continued as a form of nourishment for a time.

In chronic diseases attended with great debility, want of appetite, and possibly sickness, as well as fever, such as pulmonary phthisis, Alcohol will also find its place as a true food and antipyretic.

As a **stimulant** the principal use of Alcohol is in connection with the heart. This, as we have just seen, is an important part of its action in fever. Of all remedies in threatening death by cardiac failure (syncope, fainting, hæmorrhage, shock), Spirits are the best, being at once available, convenient, rapid in their action, and almost invariably successful if recovery be possible. For this purpose, Brandy, Whisky, etc., should be given either pure or only slightly diluted, by the stomach or bowel, or under the skin. Hardly less valuable is Alcohol, given continuously in small regular doses, in chronic disease of the heart, when natural hypertrophy fails and dilatation ensues. Wine, Rectified Spirit, or various Tinctures may be prescribed in such cases.

In *nervous* depression Alcohol must be ordered with the greatest hesitation. In melancholia, or in despondency begotten by grief, anxiety, suspense, over-work, excess, and

especially by indulgence in Alcohol itself, this drug affords only too ready relief, as also in neuralgia, hysteria and allied disorders, and sleeplessness; and the recommendation of it by the practitioner may be the perfectly innocent beginning of the alcoholic habit, or be abused by the patient and employed as a pretext for continued intemperance. In such cases the best rule is to order a definite amount of some weak alcoholic drink, such as Ale or Claret, at meal-times only; but even this recommendation is by no means always safe. Severe pain, such as neuralgia, is often successfully relieved on the same principle. Some forms of sleeplessness are readily overcome by warm alcoholic draughts at bed-time, or malt liquors: but here again great discrimination is requisite in ordering the remedy.

5. REMOTE LOCAL ACTIONS AND USES.

Alcohol given in medicinal doses is almost entirely oxydised in the system, as we have seen, less than 3 per cent. passing out unchanged, chiefly by the lungs, less by the kidneys, and least by the skin. This amount, however, includes ethereal and other complex bodies associated with Alcohol in Wines and Spirits; by far the greater part of the Alcohol proper is excreted as carbonic acid and water.

The **diuretic** effect of Spirits, Wines, and especially Gin and Beer, is well known, and may sometimes be employed in medicine. The **diaphoretic** effect of Alcohol and its applications have been sufficiently discussed under fever (p. 164).

Circumstances modifying the actions and Uses of Alcohol.—The different alcoholic fluids act very differently, according to their strength; their other constituents, already enumerated; the presence of carbonic acid in them (sparkling drinks), which increases the rapidity of their action on the stomach and possibly of their absorption; the degree to which they are diluted with water; and the condition of the stomach as regards the presence of food. The age of the patient, the soundness of his kidneys and other eliminating organs, his habits as regards Alcohol, and the amount of exercise which he can take, must also be carefully estimated in ordering the remedy. Necessarily the nature of the disease for which the Alcohol is ordered chiefly determines its form and amount. In conditions of waste and exhaustion, especially febrile states and after operations, large quantities (even 1 pint of Brandy per diem) can sometimes be tolerated, apparently from the rapidity of oxydation of the Alcohol in the system.

CHLOROFORM AND ETHER.

Chloroformum.—CHLOROFORM. Chloroform or Trichloromethane, $CHCl_3$, to which has been added sufficient Absolute Alcohol to produce a liquid having a sp. gr. not less than 1·490 and not more than 1·495.

Source.—Made by (1, 2, and 3) distilling Alcohol with Chlorinated Lime and Slaked Lime (oxydising and chlorinating the alcohol); thereafter (4) purifying by washing with Water and with Sulphuric Acid; agitating with Slaked Lime and Calcium Chloride, and redistilling; and lastly adding Absolute Alcohol. (1) $2C_2H_6O + O_2 = 2C_2H_4O$ (aldehyde) $+ 2H_2O$. (2) $C_2H_4O + 3Cl_2 = C_2HCl_3O$ (chloral) $+ 3HCl$. (3) $2C_2HCl_3O + Ca(HO)_2 = 2CHCl_3 + Ca2CHO_2$ calcium formate. (4) The sulphuric acid chars and removes hydrocarbons, without affecting the Chloroform; the lime frees it from acid, the calcium chloride from moisture.

Characters.—A limpid, colourless, heavy, volatile liquid, of an agreeable ethereal odour and pungent sweet taste. *Solubility.*—10 in 7 of alcohol; freely in ether, olive oil, and turpentine; 1 in 200 of water, in which it sinks in heavy drops. Sp. gr. 1·490 to 1·495. Boils between 140° and 143·6° F. Burns with a greenish flame. *Impurities.*—Hydrocarbons; giving green colour with H_2SO_4. Non-volatile compounds, including chlorides; giving residue and unpleasant odour after evaporation, etc. Carbonyl chloride, $COCl_2$, due to decomposition through exposure to air and sunlight; detected by adding Ba. solution, when a white film forms at its junction with the Chloroform; and clinically by the constant irritating cough produced by inhalation. Carbonyl is destroyed by adding slaked lime to the Chloroform. Acids. Free Chlorine. *Dose*, 1 to 5 min. by the mouth.

Preparations.

1. **Aqua Chloroformi.**—1, well shaken in 400 of Water.

2. **Linimentum Chloroformi.**—1, to 1 of Liniment of Camphor.

3. **Spiritus Chloroformi.**—Spirit of Chloroform. Chloric Ether. 1 to 19 of Alcohol 90 per cent. *Dose*, 5 to 20 min. for repeated administration; 30 to 40 min. for a single dose.

4. Tinctura Chloroformi et Morphinæ Composita.—Made by dissolving 10 of Morphine Hydrochloride in a mixture of 1·5 of Oil of Peppermint, 450 of Alcohol 90 per cent., 75 of Chloroform, 25 of Tincture of Capsicum, 100 of Tincture of Indian Hemp, and 250 of Glycerin; adding 50 of Diluted Hydrocyanic Acid; and increasing the volume to 1000 by further addition of Alcohol.—10 min. contain $\frac{3}{4}$ min. of Chloroform, $\frac{1}{11}$ gr. of Morphine Hydrochloride, and $\frac{1}{2}$ min. of Diluted Hydrocyanic Acid. *Dose*, 2 to 15 min.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally applied, and allowed to evaporate, Chloroform causes a sense of coldness, and depresses the terminations of the sensory nerves of the part, thus reducing sensibility or removing pain. On the contrary, if the vapour be confined or the Chloroform rubbed into the skin, it acts as an irritant, causing redness and even vesication, with a sense of heat and pain, followed by anæsthesia of the part. A similar effect is produced on all exposed mucous membranes. As a **local anæsthetic,** Chloroform may be applied on lint, covered closely with a wine-glass, *e.g.* in temporal headache; or in the form of the Liniment or of various combinations with Belladonna and other anodynes which are used for the relief of lumbago, neuralgia, etc. The student must understand, however, that the local anæsthetic effect of Chloroform bears a very inferior relation to its rapid and powerful action as a general anæsthetic to be presently described.

When given *internally* by the mouth, Chloroform produces an intensely hot, sweet taste, which renders it useful in pharmacy to cover the nauseous, bitter and astringent characters of many drugs. It may also be used to relieve toothache. Like Alcohol, it causes reflex salivation, and in this way, as well as by a **carminative** action on the stomach, the Spiritus and Aqua are useful adjuvants to stomachic and tonic mixtures, relieving pain, vomiting and flatulency. In full doses it may give rise to vomiting, as is frequently seen after anæsthesia, but this effect is often referable to carbonyl chloride, a product of decomposition. The Compound Tincture of Chloroform and Morphine is a substitute for "Chlorodyne," a popular sedative and intestinal astringent. A few drops of Chloroform inhaled from a sponge or piece of lint (quite apart from its action and use as a general anæsthetic),

rapidly soothe the respiratory nerves, and may be employed to arrest spasm of the glottis, asthma, and spasmodic or dry useless cough attending irritation of the air-passages.

2. ACTIONS IN THE BLOOD.

Chloroform enters the circulation by the respiratory organs, stomach and unbroken skin, as well as subcutaneously. Chiefly as Chloroform, partly as various products, it mixes with the blood; but its action on the circulating blood is still obscure. It is carried mainly by the red corpuscles.

3. SPECIFIC ACTIONS AND USES.

Chloroform reaches the tissues very rapidly, especially if administered in the form of vapour freely mixed with air, as it always is when given as a **general anæsthetic.** Its most important action is exerted upon the central nervous system, and demands detailed description. Whilst this description of the subject of anæsthetics will have particular reference to Chloroform, it will also apply in a general way to other agents of the same class, especially Ether; important differences being noticed under each drug. The phenomena of general anæsthesia will first be noted; secondly, an analysis will be made of these; thirdly, the uses of Chloroform will be enumerated; and fourthly, the methods of administering the anæsthetic, and certain necessary precautions, will be briefly indicated.

1. **Phenomena of Chloroform Anæsthesia.**—*a. First stage.* The first effect of the inhalation of Chloroform on the nervous system is powerful **stimulation,** but almost from the commencement this is accompanied by a certain amount of disorder. The very first inspiration seems to rouse the cerebrum to increased activity, an effect due to the direct action of the anæsthetic on the nerve cells of the *convolutions,* partly, perhaps, to vascular disturbance. The highest centres are first and chiefly excited, so that the imagination and feelings immediately become exalted; always, however, with some confusion. For a moment the senses may be quickened, but they are speedily disordered and depressed; vision, hearing and touch become dulled, and a strange feeling of lightness, freedom, tingling and numbness pervades the surface and the extremities. All these sensations are strictly central, probably convolutional, in origin.

b. Second stage.—The Chloroform next rouses the *muscular centres,* and various gesticulations, spasms or struggling movements may ensue. The *medulla oblongata* is next affected, the *centres of circulation and respiration* being

stimulated, so that the pulse and respiration become more frequent (although the latter is more shallow), the face is flushed, the blood-pressure raised. At this point the skin becomes moist; a red rash in irregular patches may appear on the neck and chest; and the pupils may dilate slightly. These phenomena vary greatly in different instances, with the constitution and condition of the nervous centres, the temperament and habits of the individual; laughing or crying or noisy struggling being the prominent feature in many cases.

c. Third stage.—The third effect of Chloroform on the nerve centres is **depression.** The same parts continue to be affected by the drug; but their functions, instead of being increased or simply disordered, are first diminished and at last perfectly arrested. Consciousness now ceases, with the appearance of heavy sleep. Perception and sensation are annulled; the patient sees nothing, hears nothing, feels no pain. For the same reason, reflex excitability is first diminished and then lost; irritation of any part by tickling or pinching induces no movements of the limbs; at last, even touching the cornea causes no reflex rolling of the eye-ball nor winking of the lids.

As the anæsthesia deepens, the automatic and reflex excitability of the *cord* and *medulla* is also diminished, and the phenomena that ensue involve all the parts supplied by these centres. Muscular tone is lost, and the voluntary *muscles* become paralysed and relaxed. The pupil is contracted, dilating on stimulation of afferent nerves. The heart and respiratory organs are no longer excited, but their centres in the medulla being now depressed, their action is laboured: the pulse falls in frequency and in force; the heart is directly weakened, becomes atonic, and dilates; and the respiratory movements become slow, heavy, and attended with noise or stertor.

Now is the time for the surgeon to operate, general anæsthesia being complete, whilst depression of the vital functions is still within safe limits. The effects may be expected to begin to pass off in a few minutes if the administration be stopped; and although the amount of Chloroform required to complete the third stage varies greatly with the subject and other circumstances, it may be said that from 1 to 4 fluid drachms will probably have been given up to this point.

Beyond the third stage or degree, just described, Chloroform anæsthesia is highly dangerous, the further action of the drug being attended by complete **loss of all reflex**

excitability of the cord and medulla. The sphincters relax, the pupils are widely dilated and fixed, the globes prominent. The respiratory centre is no longer irritable, and the movements of the chest become weaker, irregular and sighing, and finally cease. The cardiac centre and myocardium fail; the heart beats irregularly and feebly, and at last stops in diastole, both from central and from direct nervo-muscular depression. The blood-vessels dilate, the pressure falls to zero, the circulation has come to a standstill. The direct effects of Chloroform on the respiratory centre are complicated by venosity of the blood, and by interference with the afferent impulses from the air passages and lungs. Death may occur through the heart, the respiration, or both.

2. **Analysis of the phenomena of Chloroform anæsthesia.**—Chloroform anæsthesia affords us an excellent opportunity of studying the actions of a drug upon the various centres of the nervous system, from the highest downwards. The first parts to be stimulated are the cerebral centres with mental functions and control of the special senses and consciousness; and these are the first to be depressed and finally annulled. The lower cerebral and the spinal centres are affected less and somewhat later, so that a certain degree of excitement of these accompanies the first cerebral depression; and the spinal centres being no longer controlled by the cerebral, irregular excessive movements of the limbs ensue. As the depression deepens in the spinal centres, the muscles are paralysed. Lastly, the lowest centres of all, in the medulla and cord, those of organic life—of the heart, vessels, respiratory organs and sphincters—and the heart itself yield to the action of Chloroform. Although affected from the first, the functions of these vital centres are not seriously impaired until the higher parts have become completely overpowered; then death threatens. It is on account of the safe order of invasion of the different centres by Chloroform, that it has been selected as a proper agent for temporarily arresting consciousness; we shall find that many other powerful drugs equally depress the nervous system, but in a direction exactly the reverse.

The peripheral nerves are affected last of all in general anæsthesia; and it must be repeated that the loss of sensibility to the knife is due to a central, not a peripheral, effect.

The muscles are finally affected directly, as well as through the nervous system. The pupil is dilated in the first stage, probably by stimulation of the sympathetic; contracted in the second, and dilated in the third stage, by stimulation and

paralysis respectively of the third nerve or its cerebral centre. The other involuntary muscles are less obviously paralysed, and the parturient uterus contracts freely in complete anæsthesia, with some loss, however, of vigour and regularity.

3. **Specific uses of Chloroform.**—The circumstances in which Chloroform anæsthesia may be employed are the following:—(1) In *operations attended with pain.* These need not be particularised. (2) In *operations where muscular action or spasm has to be overcome:* reduction of herniæ, dislocations and fractures; catheterism. (3) In *diagnostic manipulations:* exploration of the abdomen externally and *per rectum.* (4) In *diseases attended with excessive pain,* especially biliary and renal calculus. (5) In *parturition,* in certain subjects and conditions, the degree of anæsthesia induced being generally slight until the moment of birth. (6) In *spasmodic diseases,* such as tetanus, hydrophobia, uræmia, puerperal convulsions, the *status epilepticus,* severe chorea and hiccup.

4. **Method of administration, and principal precautions to be observed in Chloroform anæsthesia.**—This is a purely practical subject, to be learned by experience and not in theory only. The student has frequent opportunities of witnessing the administration of anæsthetics by skilled persons, and is now systematically trained in it; and he must closely and carefully observe every effect of the Chloroform upon the patient. He will do well to interpret every phenomenon as it arises, such as mental and muscular excitement, the character of the breathing, the colour of the countenance, and (if possible) the state of the pulse, into exact physiological terms, as explained above; as, for example, stimulation of the convolutions and cord, interference with the respiratory centre, etc. He will thus come to appreciate accurately the condition of the patient at any moment, and be prepared to administer anæsthetics for himself. A number of thoroughly practical points will then have to be learned: the selection of suitable cases for anæsthesia; the preparation of the patient; the choice of the anæsthetic and of an inhaler; the position of the patient; the method of watching the face, eyes, pulse and respiration; the detection of unfavourable symptoms, and their immediate treatment; and, finally, the after-treatment of the case. All these and other matters connected with the administration of anæsthetics can be but briefly referred to in the following paragraphs:

a. Selection of cases.—Chloroform must be given with great caution to the aged and infirm. To children, to persons subject to attacks of faintness or known to suffer from fatty degenera-

tion or dilatation of the heart, to very fat and very anæmic persons, to epileptics, to chronic drunkards, to subjects of extensive disease of the lungs or respiratory passages the A.C.E. Mixture, C.E. Mixture, or other Chloroform Mixture should be given. Alcoholics take Ether better than Chloroform. Valvular disease of the heart with compensation suggests special care, but is not a contra-indication. Operations on the mouth, nose or throat, with possible bleeding into the glottis, demand special precautions: deep anæsthesia is not desirable—the cough reflex should not be abolished. Preliminary tracheotomy may be necessary. It must never be forgotten, however, that when an operation is absolutely necessary, it can always be more safely performed with than without anæsthetics; and that before the days of Ether or Chloroform many persons died during operation from fear, faintness and shock, the danger of which is removed or greatly diminished by anæsthetics.

b. Preparation of the patient.—Insensibility is produced more rapidly when the stomach is empty. No food should be given for at least four hours before the operation, which should, if possible, be performed early in the morning: patients take an anæsthetic then better than at any other period of the day. If the patient feel faint, a small quantity of brandy and water may be given before operation. Artificial teeth must be removed, especially small plates, but whole plates may be retained with advantage. The respiration and pulse should be carefully noted before commencing inhalation.

c. Selection of the anæsthetic: purity of the same.—The anæsthetic agents in general use at the present time are Nitrous Oxide, Nitrous Oxide and Oxygen, Ethyl Chloride, Ether, Chloroform, A.C.E. Mixture (Alcohol 1, Chloroform 2, Ether 3), and other mixtures containing Chloroform and Ether. Of these, Nitrous Oxide and Ether are unquestionably to be preferred unless there be some special reason to the contrary. The purity of the drug is best ensured by purchasing it from well-established makers, and not attempting to test it for oneself; and the same manufacture should always be used, if possible. It may be advisable to commence with one anæsthetic, and then, as circumstances alter during the operation, to change it for another.

d. Selection of the apparatus.—This will depend on circumstances and on the skill and experience of the administrator. Whilst elaborate inhalers are used in hospitals, it is satisfactory to know that the simplest apparatus may be equally safe, such as a handkerchief or piece of lint or flannel

stretched over a wire frame; care being taken that the Chloroform vapour is mixed very freely with air. A few capsules of Amyl Nitrite, Solution of Strychnine, a pair of straight tongue forceps, and a tracheotomy case should be ready at hand.

e. Position of the patient.—The administrator must accommodate himself to the convenience of the operator, whose eye and hand must never be interfered with. If possible, the patient's head is so placed on the edge of a pillow that the saliva may flow from the mouth instead of into the stomach, and that the tongue may remain forward and not fall back and produce dyspnœa. The patient's chest and abdomen must not be compressed by clothes, instruments, bowls or the arms of the assistants, nor confined by bandages. The most comfortable position for the patient is on the side, with one hand and fore-arm beneath the pillow; and as a rule it is better to induce insensibility in this position, and afterwards arrange the patient for the surgeon, than to anæsthetise him in the constrained attitude often required in operations.

f. Administration.—The confidence of the patient should first be gained by a few minutes' conversation, whilst he is reassured as to the result and instructed how to breathe. When inhalation has commenced, the administrator must not, even for a single instant, cease to watch the face, respiration, and pulse. The degree of insensibility necessary for different cases varies greatly, the least being required for uterine, the most for rectal operations. The loss of the corneal reflex and stertorous breathing are generally employed as tests of insensibility, but no single sign can be relied upon. The smallest possible quantity of the drug should always be given.

g. Complications and unfavourable symptoms.—*Vomiting* is generally preceded by pallor of the face or a few deep inspirations. When it threatens, care must be taken, by affording a free vent, that nothing is drawn into the larynx; the head should be thrown more over to the side, and the mouth opened by pressure on the symphysis, or by inserting a Mason's gag between the teeth. Should vomited matter be inhaled into the respiratory passages and asphyxia threaten, laryngotomy must be performed immediately.

Lividity of the face and prolonged deep *stertor* should be checked by temporarily discontinuing the anæsthetic, providing a free air-way, and permitting the patient to breathe more fresh air. The position of the head is to be changed until respiration is more easy, and the mouth may have to be opened to its fullest extent, which induces a deep inspiration, the following expiratory effort often clearing the larynx and fauces of tenacious mucus which has been obstructing the

free entrance of air; but, failing this, it may be necessary to swab out the mucus from the pharynx.

Pallor of the face is to be met by lowering the head and shoulders and brisk friction of the gums with a rough towel; if severe, by dropping the head over the end of the table. If this fail, the vapour of Amyl Nitrite should be given.

Shallow breathing, especially if intermittent, should be watched anxiously: and if it increase, artificial respiration should be resorted to at once, on no account waiting for the respiration to cease.

h. After-treatment.—Absolute quiet and keeping the eyes closed often prevent sickness after operation. If Ether have been administered, the whole surface of the body having been carefully covered to prevent chill, the room should be cleared of the vapour as quickly as possible. Food should not be given within three hours after the operation, and not even then unless the patient desire it; and for the first twelve hours should be entirely cold, and consist chiefly of soups and jellies, milk being avoided. A teaspoonful of burned brandy will often relieve the after-sickness when all other measures have failed.

4. REMOTE LOCAL ACTIONS.

Chloroform is excreted in part, as such, by the kidneys, lungs, mammary glands and skin; part is lost in the system. No use is made of its remote effects, although small doses given by the mouth are said to increase all the secretions.

Æther.—ETHER. "Sulphuric Ether." A volatile liquid, containing at least 92 per cent. by volume of Ethyl Oxide, $(C_2H_5)_2O$.

Source.—Made by (1 and 2) distilling 50 fl.oz. of Ethylic Alcohol, added in a continuous stream, with 10 fl.oz. of Sulphuric Acid; (3) agitating with Slaked Lime and Calcium Chloride in Water, and redistilling. (1) $C_2H_6O + H_2SO_4 = C_2H_6SO_4$ (sulpho-vinic acid) $+ H_2O$. (2) $C_2H_6SO_4 + C_2H_6O = (C_2H_5)_2O + H_2SO_4$. The process of etherification is thus *continuous*, sulphuric acid being re-formed and acting on a fresh quantity of alcohol. *Heavy Oil of Wine* is also formed in the first part of the process, along with Ether and Water. This substance is either a mixture of Ethyl Sulphate $(C_2H_5)_2SO_4$, Ethyl Sulphite $(C_2H_5)_2SO_3$, and a polymeric form of Ethylene (C_2H_4); or a sulpho-vinate of a hydrocarbon radical. It smells somewhat like peppermint; is not soluble in water, but readily in alcohol and ether. Process (3) removes alcohol, water and the oil of wine.

Characters.—A colourless, very volatile liquid, with a peculiar strong odour and hot taste. It is entirely dissipated in vapour when exposed to the air, forming an explosive mixture; boils below 105° F.; and is very inflammable, burning with a white flame. Sp. gr. 0·735. Miscible in all proportions with Alcohol 90 per cent., Chloroform, and fixed and volatile oils. *Impurities.*—Excess of Ethylic Alcohol; oil of wine, giving odour on evaporation. Free Acid. Ethyl peroxide $(C_2H_5)_2O_2$, giving tests of H_2O_2. *Dose*, 10 to 30 min. repeated; 40 to 60 min. for single dose (*by inhalation*, 4 to 6 dr. to several fl.oz.).

Preparations.

1. **Æther Purificatus.**—Purified Ether. Ether from which most of the Ethylic Alcohol has been removed.

Source.—Made by washing with Distilled Water, and subsequent distillation in the presence of Calcium Chloride and recently-prepared Lime to remove most of the Water.

Characters.—Sp. gr. not exceeding 0·722 and not below 0·720. *Impurities.*—Alcohol, water, methylic ether, ethyl and hydrogen peroxides.

2. **Spiritus Ætheris.**—Ether, 1; Alcohol 90 per cent., 2. Sp. gr. 0·806 to 0·811. *Dose*, 20 to 40 min. repeated; 60 to 90 min. for a single dose.

From Spiritus Ætheris is prepared:

Tinctura Lobeliæ Ætherea. See *Lobelia*, page 330.

3. **Spiritus Ætheris Compositus.** — Compound Spirit of Ether. Hoffmann's Anodyne.

Source.—Made by (1) distilling 900 of Sulphuric Acid with 1,000 of Alcohol 90 per cent., after the liquids have been mixed for twenty-four hours. (2) Shaking the upper layer of the distillate with 37·5 of Distilled Water, and a sufficiency of Sodium Bicarbonate to neutralise any acid; removing the supernatant liquor; and pouring the resulting Oil of Wine into a mixture of 137·5 of Ether and 950 of Alcohol 90 per cent. *Dose.*—20 to 40 min. repeated; or 60 to 90 min. for a single dose.

Characters.—A colourless, mobile liquid, with characteristic ethereal odour and taste. Sp. gr. 0·808 to 0·812.

Ether is also used in making Collodium, Collodium Flexile, Tinctura Lobeliæ Ætherea; and in many pharmaceutical processes.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—When allowed to evaporate, Ether is a powerful **refrigerant and local anæsthetic,** abstracting heat and depressing the nerves of the part. It is used in the form of Richardson's spray to relieve the intense local pain of neuralgia, and more frequently to prevent pain in minor surgical operations, the parts being completely frozen in the course of a few seconds by a spray of Purified Ether from a proper apparatus. If the vapour be confined, or the Ether rubbed into the skin, a **rubefacient or vesicant** effect is produced, as with Chloroform.

Internally.—Ether has a powerfully burning disagreeable taste, and causes local irritation and reflex **salivation** in the mouth like Chloroform. Reaching the stomach, either in the pure form, or as the simple or Compound Spirit, it acts as a local **stimulant** to the blood-vessels, nerves and muscular coat, and is therefore used as a **carminative,** relieving pain and sickness and expelling flatulence, especially in nervous subjects. At the same time, it acts reflexly from the gastric mucosa upon the bowels, heart and respiratory organs, as a powerful **systemic stimulant.** It is a very useful ingredient of **anti-spasmodic** draughts, as will be presently described. Given with Cod-liver Oil, it renders it more palatable to some patients, and more digestible, possibly by emulsifying it and also by stimulating the pancreas.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

Ether is absorbed into the blood with remarkable rapidity, and probably acts here like Chloroform.

The specific actions of Ether and its employment as an **anæsthetic** so closely agree with those of Chloroform, that the reader is referred to the description of them under the latter drug (page 168). Only the important differences between the two substances require to be mentioned here. These are:

1. Ether must be administered nearly pure, say 70 per cent. of the vapour with 30 per cent. of air; whilst but 2 to 4 per cent. of Chloroform is given, with 98 or 96 per cent. of air.

2. With Ether the stage of stimulation is more protracted; there is more struggling, unless it be preceded by Nitrous Oxide, and the stage of anæsthesia is shorter and the degree less profound. Ether is therefore said to be safer, but less convenient, than Chloroform.

3. Ether depresses the heart and vessels less than Chloroform, the heart continuing to beat after respiration has been arrested by an excessive dose. The respiratory centre is also less depressed. For these reasons, also, Ether is called a safer anæsthetic. Chloroform is ten times more poisonous.

4. Ether has a much less pleasant odour than Chloroform.

5. The after-effects of Ether, in the form of sickness and bronchial catarrh, are more common and more severe than those of Chloroform.

In choosing between Ether and Chloroform, preference must be given to the **safer anæsthetic,** and at the present day Ether is very extensively used in England and America. In certain circumstances Chloroform is preferable, as in operations about the mouth, Ether causing a profuse secretion of ropy mucus; in operations where a light or cautery might come in contact with the Ether vapour and cause an explosion; in operations which must be hastily undertaken and completed; and in parturition, where profound anæsthesia is unnecessary. Infants bear Chloroform better, and their delicate respiratory passages are less irritated by it than by the pungent vapour of Ether; but it is not to be regarded as a specially safe anæsthetic for children.

Given by the mouth in small doses, Ether increases the activity of the circulation and nervous system—in part, as we have seen, by reflex action from the gastric wall, in part specifically; and is used as a powerful and rapidly **diffusible stimulant and antispasmodic.** As the Spirit, as Hoffman's Anodyne, or hypodermically, it is given in cardiac failure, angina pectoris, palpitation and depression, being even more rapid in its effects than Alcohol, but more evanescent and of course less available in emergencies. Its antispasmodic powers make it useful in hysterical and epileptic threatenings; and in spasmodic cough and asthma it is one of the most valuable remedies during the seizure.

3. REMOTE LOCAL ACTIONS AND USES.

Ether is excreted like Chloroform, and to a certain extent increases all the secretions, but is not employed with this end in view.

Nitrous Oxide Gas.—N_2O. "Laughing Gas." (*Not official.*) Although not a Carbon compound, Nitrous Oxide Gas will be discussed here, being closely allied therapeutically to Ether and Chloroform.

Source.—Made by heating Ammonium Nitrate to 350° or 450° F., and washing the gas. $NH_4NO_3 = N_2O + 2H_2O$.

Characters.—A colourless inodorous gas. It is provided for use condensed into a liquid, in strong iron bottles, whence it is allowed to escape into a caoutchouc bag.

ACTIONS AND USES.

1. ACTION ON THE BLOOD AND ITS USES.

Nitrous Oxide Gas, administered from an inhaler, air being rigidly excluded, rapidly enters the circulation; is absorbed by the plasma; converts the arterial into venous blood in the course of about sixty seconds; and thus **produces partial asphyxia.** This partial asphyxia has nothing to do with the anæsthetic properties of N_2O, but is merely due to the method of administration. But Nitrous Oxide has also true anæsthetic properties, because when Oxygen is administered in conjunction with it, anæsthesia results, with total absence of all signs of asphyxia: the patient retains a natural colour; there is no stertor, cyanosis or muscular twitchings; and he might be mistaken by an onlooker for a person in natural slumber.

2. SPECIFIC ACTIONS AND USES.

Nitrous Oxide Gas, when given pure, not only renders the blood venous, but simultaneously enters the nervous centres, upon which it acts, first as a stimulant, and speedily as an **anæsthetic.** Thus the gas produces a series of phenomena which can be resolved into the parallel effects of venosity of the blood or asphyxia, and a specific influence on the nerve cells of the convolutions. After a few seconds' excitement, the subject of anæsthesia by Nitrous Oxide begins to breathe laboriously; the mind becomes rapidly obscured; and, by the end of sixty seconds or more, consciousness is lost, the face becomes somewhat livid, respiration becomes stertorous, the pulse is feeble at the wrist, and muscular twitchings occur. If the inhalation be now interrupted, perfect recovery of consciousness and of natural breathing occurs in thirty to sixty seconds, with disappearance of all the urgent symptoms. It is clear that asphyxia is carried into the second stage, that

of respiratory excitement, but not beyond, neither the movements of the chest nor the action of the heart being arrested. But even if these untoward results should occur, resuscitation is easy by means of artificial respiration; it is said even after five minutes in the case of rabbits.

Nitrous Oxide Gas is used to produce anæsthesia during operations of one minute or less, especially by dental surgeons for the extraction of teeth, destruction of the nerve, etc. Operations requiring several minutes' anæsthesia can be performed by employing an intermittent administration of gas and air. The moment for operating is best indicated by stertorous breathing and twitching of the muscles. Persons with diseased vessels, such as the subjects of chronic Bright's disease, ought not to take this anæsthetic, which produces (like all asphyxiating agents) a great and sudden rise of the arterial pressure, liable to cause rupture within the brain. Nitrous Oxide and Oxygen should be substituted in such cases. Nitrous Oxide administration is being rapidly superseded by Nitrous Oxide and Oxygen (2 to 9 per cent.); the latter mixture of gases being infinitely preferable in the vast majority of cases, and enabling anæsthesia to be greatly prolonged.

Liquor Sodii Ethylatis.—Solution of Sodium Ethylate.

Source.—Made by dissolving 1 of Sodium in 20 of Absolute Alcohol.

Characters.—A colourless syrupy liquid, becoming brown by keeping. Sp. gr. 0·867. Contains 18 per cent. of the solid substance C_2H_5ONa.

ACTIONS AND USES.

Solution of Sodium Ethylate is a powerful caustic, used to destroy small accessible tumours, such as nævi.

Liquor Ethyl Nitritis.—Solution of Ethyl Nitrite. A mixture of 95 parts by volume of Absolute Alcohol with 5 parts by volume of Glycerin, containing when freshly made 3 per cent. by weight, and even when long kept not less than $2\frac{1}{2}$ per cent. by weight of Ethyl Nitrite.

Source.—Ethyl Nitrite is obtained by the interaction of

Alcohol 90 per cent., Sodium Nitrite, and Diluted Sulphuric Acid, at a low temperature.

Characters.—A limpid, colourless liquid, of characteristic apple-like odour and taste. Highly inflammable. Sp. gr. 0·823 to 0·826. When it is poured on an acidified strong solution of *ferrous sulphate* contained in a test-tube, a deep olive-brown coloration is produced at the surface of contact of the two liquids, widening as the tube is gently shaken. *Impurities.*—Acid; aldehyde; deficiency in ethyl nitrite.

Dose, 20 to 60 min. (mixed with water immediately before administration).

ACTIONS AND USES.

Ethyl Nitrite possesses actions similar to those of Amyl Nitrite, **dilating the arterioles and increasing the frequency and force of cardiac systole**; but its effects are less rapid and more persistent. The Liquor has been introduced as a more trustworthy preparation of Ethyl Nitrite than Spiritus Ætheris Nitrosi, and is given in the same class of cases as the other Nitrites (*see* page 188).

Spiritus Ætheris Nitrosi.—Spirit of Nitrous Ether. Sweet Spirit of Nitre. An alcoholic solution, containing Ethyl Nitrite, Aldehyde, and other substances.

Source.—Made by distilling a mixture of 1000 of Alcohol 90 per cent., 125 of Nitric Acid, 100 of Sulphuric Acid, and 100 of Copper; dissolving the distillate in 1000 of the Alcohol, and repeating the process of distillation with 25 of Nitric Acid, and the addition of 1000 of the Alcohol. Production of *Ethyl Nitrite:* $C_2H_6O + HNO_3 + H_2SO_4 + Cu = C_2H_5NO_2$ (Ethyl Nitrite) $+ CuSO_4 + 2H_2O$. Production of *Aldehyde:* $C_2H_6O + O = C_2H_4O$ (Aldehyde) $+ H_2O$. Production of *Acetic Ether: see* page 183.

Characters.—A limpid liquid, with a very faint yellowish tinge; mobile; of a peculiar penetrating apple-like odour, and a characteristic sweetish, cooling, sharp taste. Slightly acid. Inflammable. Sp. gr. 0·838 to 0·842. *Incompatibles.*—Potassium iodide, ferrous sulphate, tincture of guaiacum, gallic and tannic acids. Emulsions are curdled by its addition. *Impurities.*—Excess of aldehyde; excess of acid; deficiency in ethyl nitrite. *Dose*, 20 to 40 min. repeated; 60 to 90 min. in one dose.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

In the stomach Spirit of Nitrous Ether is a **diffusible stimulant and carminative**, doubtless from the amount of alcohol which it contains (*see* page 161).

2. ACTIONS ON THE BLOOD.

The Nitrite of Ethyl appears to produce the same effect on the red corpuscles as other Nitrites, especially diminishing oxygenation. *See* Amyl Nitris, page 188.

3. SPECIFIC ACTIONS AND USES.

Although a mild anæsthetic, Sweet Spirit of Nitre chiefly acts upon the circulation, like Amyl Nitrite. It relaxes the peripheral vessels and accelerates the heart; but much less quickly, less completely, and more persistently than the Amyl compound. Thus it **lowers arterial tension,** and causes the phenomena described at page 189, only in a much less degree. By relaxing the renal vessels it is diuretic, the water being increased; by dilating the cutaneous vessels, as well as by stimulating perspiration, it increases the loss of heat from the skin. Nitrous Ether is chiefly used as an **antipyretic** in febrile affections, where it diminishes the heat production by acting on the blood, and increases the loss of heat through the skin and kidneys. As a **diuretic** it is useful when a free watery flow is desired, to wash out the tubules and passages and relax spasm in the renal vessels, as in some cases of Bright's disease with increased arterial tension. Probably for the same reason it fails as a diuretic in cardiac dropsy, where the veins demand relief, and the arterial pressure is already too low. Being a dilator of the renal vessels, it must not be used in acute inflammatory states of the kidneys. Spirit of Nitrous Ether may also relieve angina pectoris, and cardiac pain dependent on a failing and dilating heart in chronic Bright's disease. Like other Nitrites, it may benefit dysmenorrhœa and asthma.

Aldehyde, one of the constituents of Spiritus Ætheris Nitrosi, and a colourless mobile liquid with an acrid suffocating odour, has a powerfully stimulant action on the cerebrum, followed by anæsthesia with respiratory depression.

4. REMOTE LOCAL ACTIONS.

Sweet Spirit of Nitre or its constituents are chiefly excreted by the kidneys and lungs. Its diuretic influence has just been described.

Paraldehydum.—PARALDEHYDE. $C_6H_{12}O_3$.

Source.—A product of the polymerisation of aldehyde by various acids and salts.

Characters.—A clear, colourless liquid; odour characteristic, ethereal; taste acrid, afterwards cool. Congeals below 50° F.; sp. gr. ·998. *Solubility.*—1 in 10 of water at 60° F., less in hot water; the solution is neutral. Miscible in all proportions with alcohol 90 per cent. and ether. *Dose*, 30 to 120 min. (in Almond Mixture or with Tincture of Quillaia).

ACTIONS AND USES.

Paraldehyde possesses important physiological actions on the cerebrum and respiratory organs. It rapidly enters the system, and acts as a pure **hypnotic**. This effect is fairly certain, and the sleep produced is quiet and refreshing, whilst it is accompanied by little or no depression of the heart. Paraldehyde is used to procure sleep, particularly in the insane, or where other hypnotics might be unsafe, as in cardiac and respiratory diseases. Its excretion by the lungs makes it a valuable drug in bronchial asthma. Unfortunately, it has a very unpleasant taste, and imparts a disagreeable ethylic odour to the breath. It may be given *per rectum*.

Urethan.—(*Not official.*) Carbamic Ether. $CO(NH_2)(O{\cdot}C_2H_5)$.—White inodorous crystals, with a pleasant taste like nitre; readily soluble in water. *Dose*, 10 to 30 gr.; 120 gr. or more have been given with safety.

ACTIONS AND USES.

Urethan is a **hypnotic**, and is said to be a respiratory stimulant, less depressing to the circulation than Chloral Hydrate, and more pleasant and active than Paraldehyde. It is excreted in the urine as urea. It is, however, an uncertain remedy.

Æther Aceticus.—ACETIC ETHER. An ethereal liquid consisting of Ethyl Acetate, $CH_3{\cdot}COO\ (C_2H_5)$, with unimportant amounts of Ethylic Alcohol and other substances.

Source.—Made by (1) distilling Ethylic Alcohol with dried

Sodium Acetate and Sulphuric Acid; (2) digesting the distillate with dried Potassium Carbonate; and (3) separating, by distillation, the portion that boils between 165° and 172° F. $C_2H_5,HO + NaC_2H_3O_2 + H_2SO_4 = CH_3{\cdot}COO\,(C_2H_5) + NaHSO_4 + H_2O$.

Characters. — A colourless liquid, with an agreeable ethereal, somewhat acetous odour, and refreshing taste. Sp. gr. 0·900 to 0·905. Neutral. *Soluble* freely in Alcohol 90 per cent., ether, or chloroform, and in about 10 parts of cold water. *Dose*, 20 to 40 min. repeated; 60 to 90 min. for a single dose.

Acetic Ether is used in making Liquor Epispasticus (p. 440).

ACTIONS AND USES.

Acetic Ether is a **stimulant and antispasmodic,** much like Ether itself, but forms more agreeable combinations with other **carminatives** on account of its pleasant odour and taste.

Chloral Hydras.—Chloral Hydrate. Trichlorethylidene Glycol. $CCl_3{\cdot}CH\,(OH)_2$.

Source.—Made from Chloral by the addition of Water. Chloral, an oily liquid, is itself made by saturating Ethylic Alcohol with dry Chlorine gas, and purifying.

Characters.—Colourless monoclinic plates, non-deliquescent, with a peculiar pungent but not acrid odour, and a pungent and rather bitter taste. Readily fused by gentle heat, recrystallising on cooling at about 120° F. *Solubility.*—1 in less than 1 of distilled water, alcohol 90 per cent., or ether; 1 in 4 of chloroform. The aqueous solution is neutral or slightly acid. Forms a fluid when rubbed with an equal weight of camphor. *Incompatibles.*—All alkalis, which decompose it, liberating chloroform (*see* p. 184). *Impurities.*—Free chlorides; chloral alcoholate; other organic substances. *Dose*, 5 to 20 gr. (in solution).

Preparation.

Syrupus Chloral.—Syrup of Chloral. 10 gr. of Chloral Hydrate in 1 fl.dr of a mixture of Water and Syrup. *Dose*, ½ to 2 fl.dr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Applied in weak solution (5 gr. to 1 fl. ounce of water), Chloral Hydrate is antiseptic. Concentrated solutions are irritant, causing vesication and possibly troublesome sores. In this form it is but little used externally. The compound with Camphor is a valuable **anodyne.**

Internally.—The Chloral and Camphor compound quickly relieves some kinds of toothache. In the stomach Chloral Hydrate is irritant unless freely diluted. It has no specially sedative effect on the stomach or bowels like Opium.

2. ACTIONS IN THE BLOOD.

Chloral Hydrate enters the blood as such; and it probably leaves it for the tissues without decomposition, although Liebreich, who introduced it into the materia medica, contended that it is broken up into chloroform and formic acid in the presence of the sodium salts of the plasma: $CCl_3 \cdot CH(OH)_2 + NaHO = CHCl_3 + NaCHO_2 + H_2O$. The blood undergoes no appreciable change.

3. SPECIFIC ACTIONS AND USES.

The actions of Chloral Hydrate upon the system so nearly resemble those of Chloroform, and the chemical relations of the two substances are so close, that Liebreich's theory is at first sight extremely plausible. Chloral Hydrate chiefly affects the nervous system, although one of the principal dangers connected with its use depends on its direct action on the heart. Given in moderate doses (20 gr.), Chloral Hydrate, after a very brief period of excitement, quickly induces drowsiness, which is followed by several hours' sound sleep, natural in its character and refreshing in its effect; as a rule, without consequent confusion, headache, or drowsiness in healthy individuals. Larger doses produce deeper and more prolonged sleep, and an appearance of narcosis, the subject being difficult to rouse even by sharp stimulation. Thus far Chloral Hydrate manifestly acts upon the convolutions, either directly or through the cerebral circulation, or both; and is a **pure and powerful hypnotic.** The larger doses, however, enable us to appreciate its action, like that of Chloroform, on the lower nervous centres. The motor centres are depressed, whence arise diminished reflex excitability and relaxation of the muscles. The three great medullary centres

are decidedly depressed: respiration becomes slow, irregular, and shallow: the heart is weakened (but chiefly in another manner, as we shall presently find); and the vaso-motor centre is lowered in activity, so that the vessels dilate generally. The peripheral sensory nerves are not specially affected. Neither are the motor nerves, nor the muscles, directly depressed.

Upon these several effects of Chloral Hydrate depend at once its value medicinally, and the drawbacks or even dangers which occasionally attend its employment. It is the most rapid, and probably the most powerful, whilst the most pure, of all the hypnotics, Opium not excepted. It is therefore extensively used to produce sleep and soothe the cerebral hemispheres in conditions of excitement; in insomnia from over-work, distress, maniacal excitement or despondency; and in the early stages of fevers or febrile diseases, whilst the heart is still strong. It is especially valuable in delirium tremens. In the sleeplessness which attends or is caused by peripheral pain, Chloral Hydrate fails, for an obvious reason; or if sleep be secured by a powerful dose, the patient wakes to suffering as before. It is totally unfitted to relieve the severe pain of neuralgia.

Chloral Hydrate has also been given in the delirium of the more advanced stages of fevers; to relieve the distress, dyspnœa and insomnia of cardiac and renal disease; and in the cough, spasm and breathlessness attending phthisis, bronchitis, and other respiratory affections. The dangers of the drug in these conditions have been shown by the fatal results which occasionally have followed its employment; and the cause of them is obvious. Besides its depressing effect on the medulla, Chloral Hydrate in full doses acts as an intrinsic cardiac poison, slowing and enfeebling the heart by diminishing the irritability of its ganglia, and finally arresting it in ventricular diastole. At the same time the blood pressure falls by peripheral paralysis of the vessel walls, as well as from the interference with the vaso-motor centre, the heart and the respiration already described; so that altogether the circulation tends to become arrested. Thus the relief to be obtained from Chloral Hydrate in the delirium of fever where the heart is threatening to fail, and in structural disease of the heart, lungs or kidneys, is but temporary and purchased at serious cost; for these purposes the drug cannot be recommended, unless it be given in very moderate doses and guarded by a stimulant like Digitalis.

The action of Chloral Hydrate in reducing the excitability of the grey matter of the cord and higher motor ganglia, has

suggested its use in tetanus, strychnine poisoning, puerperal convulsions, hydrophobia, sea-sickness and whooping cough. It has also been given as a hypnotic in some cases of chorea.

The exact effect of Chloral Hydrate on metabolism is unknown. It reduces temperature, chiefly by increased loss of heat from the dilated peripheral vessels, but also by diminishing production in the weakened muscles, etc. It may therefore be given with advantage as an antipyretic hypnotic at the commencement of fevers in strong subjects, its depressant action on the heart being carefully watched. It has been highly recommended in cholera.

4. REMOTE LOCAL ACTIONS.

Chloral Hydrate is excreted by the kidneys partly unchanged, but chiefly as glycuronic acid, producing slight diuresis and spurious glycosuria. Probably part escapes by the skin also, as a variety of eruptions may attend its prolonged use.

5. ADVANTAGES AND DISADVANTAGES OF CHLORAL; CAUTIONS; CONTRA-INDICATIONS.

It will be well to state here succinctly the advantages and disadvantages of Chloral Hydrate as compared with Morphine (Opium). Chloral Hydrate has the following *advantages:* It acts quickly as a hypnotic, even more quickly than Morphine subcutaneously; and more certainly, even when Morphine has failed. After-effects, such as headache, depression and sickness, are less common from Chloral Hydrate. It does not derange the stomach, if freely diluted; nor cause constipation, even when given for a long time. It is more safely given, in proper doses, to children.

On the other hand, Chloral Hydrate has these *disadvantages:* It does not relieve pain, and is thus greatly inferior to Opium in most cases as a hypnotic, and useless as an anodyne. It does not, like Opium, satisfactorily prevent or relieve distress, reflex dyspnœa, and cough due to cardiac and pulmonary disease. It causes excitement instead of quiet in many cases of mania, hysteria and confirmed alcoholism.

Chloral Hydrate must be given in relatively small doses to children and delicate persons; and very rarely, as we have seen, to the subjects of structural disease of the heart, lungs and kidneys, or patients suffering from gout. If it excite instead of soothing the insane or the confirmed drunkard, it should not be persevered with; nor if it increase instead of relieving sleeplessness in certain individuals, as it does occasionally, apparently from idiosyncrasy. Lastly, Chloral

Hydrate must be prescribed with great hesitation to persons who suffer from constitutional debility of the nervous system, expressing itself in despondency, excitability, hysteria and innumerable other forms. Such subjects very readily acquire the "Chloral habit"; that is, they consume on their own account regular and ever-increasing quantities of the drug, until the nervous system and general nutrition fail, the mind is demoralised, and the victims ultimately perish like the drunkard and opium-eater.

Butyl-Chloral Hydras.—Butyl-Chloral Hydrate. Trichlorbutylidene Glycol. $CH_3 \cdot CHCl \cdot CCl_2 \cdot CH(OH)_2$. "Croton-Chloral Hydrate."

Source.—Made from liquid Butyl-Chloral by the addition of Water. Butyl-Chloral is itself made by passing dry chlorine gas through aldehyde; and separating by fractional distillation.

Characters.—Pearly-white trimetric laminæ, with a pungent but not acrid odour, somewhat like that of Chloral Hydrate, and an acrid nauseous taste. *Solubility.*—1 in 50 of water; 1 in 1 of glycerin, or of alcohol 90 per cent.; slowly dissolves in 20 parts of Chloroform. The aqueous solution is neutral or but slightly acid. *Incompatibles.*—As of Chloral Hydrate. *Impurity.*—Chloral Hydrate. *Dose*, 5 to 20 gr.

ACTIONS AND USES.

In every important respect the actions of Butyl-Chloral Hydrate are nearly allied to those of Chloral Hydrate, and it will therefore suffice to indicate the points wherein the two drugs differ.

Butyl-Chloral Hydrate as a **hypnotic** is less rapid, less certain and less powerful than the other, which is generally to be preferred for this purpose. It is believed that the compound is less depressant to the heart, and therefore that it may be given in insomnia with cardiac weakness where Chloral Hydrate would be inadmissible. We must accept this recommendation with great caution. The most important effect of Butyl-Chloral Hydrate, peculiar to itself, is **anæsthesia** of the region of the trigeminus, that is, of the face and part of the scalp, preceding sleep. The drug relieves some cases of *tic-douloureux* and facial neuralgia very quickly; in some cases it fails. It has been given in other forms of pain in the

face, such as toothache (locally); in neuralgia of the limbs; and in dysmenorrhœa.

Amyl Nitris.—AMYL NITRITE. A liquid consisting chiefly of Iso-amyl-nitrite, $C_5H_{11}NO_2$, but containing also other nitrites of the homologous series.

Source.—Produced by the interaction of nitrous acid and amylic alcohol which has been distilled between 262° and 270° F.

Characters.—An ethereal liquid, of a yellowish colour, fragrant odour, and the faintest acid reaction. Sp. gr. ·878 to ·880. Volatilises between 194° and 212° F. *Solubility.*—Readily in alcohol 90 per cent.; almost insoluble in water. *Impurities.*—Amyl-nitrate, amyl-alcohol, excess of aldehydes and water.

Dose.—The vapour of 2 to 5 min. (as inhalation from a crushed capsule; or ½ to 1 min. internally, dissolved in rectified spirit, 1 to 12).

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Applied *directly* to peripheral nerves, Amyl Nitrite depresses or paralyses them. It is never so employed in man. *Internally*, the drug is seldom given by the mouth, except in cholera.

2. ACTIONS ON THE BLOOD.

Amyl Nitrite is usually administered by inhalation, a few minims being kept ready for use in a glass capsule (enveloped in cotton wool), which may be broken between the fingers and thumb when required. The vapour instantly enters the circulation through the lungs, converts a certain amount of hæmoglobin into methæmoglobin, and thus interferes with the oxygenating functions of the red corpuscles; the volume of oxygen absorbed (in animals) being quickly lowered, as well as the excretion of carbonic acid. The blood of animals killed by Amyl Nitrite is of a chocolate colour; but the effect of an ordinary inhalation in man is very transitory.

3. SPECIFIC ACTIONS AND USES.

Amyl Nitrite almost instantaneously reaches the tissues (where the nitrous acid is possibly liberated), and produces striking phenomena. Two to five minims, inhaled as directed, immediately produce a sense of fulness and throbbing in the

head; visible pulsation of the carotids; flushing of the face, neck and trunk; increased frequency and force (that is, palpitation) of the heart; tingling over the surface generally; dilatation of the pupils, and disturbances of vision; giddiness and unsteady gait; restlessness and anxiety of mind. These symptoms quickly disappear, possibly leaving slight headache. Larger doses aggravate all the phenomena, but never produce unconsciousness; the result being mental confusion, intense bodily depression, coldness of the extremities and sweats, followed by severe headache, which may last for hours. Very rarely convulsions occur in man as in some of the lower animals.

The specific action of Amyl Nitrite proves, on analysis, to be almost confined to the circulatory system, the other parts being chiefly involved secondarily. Two distinct effects are produced on the circulation. **The peripheral vessels are dilated,** by relaxation of their muscular coat; **the heart is greatly accelerated,** with but little, if any, increase of its force. Some authorities hold that the cardiac acceleration is due to depression of the cardiac centre, consequent on the fall of pressure; others to depression of the vagus in the heart. Some refer the vascular relaxation to the action of the Nitrite on the vasor centre in the medulla, others to its action on the vaso-motor nerves and muscular walls. Be this as it may, the fact remains that **the blood pressure falls** to a remarkable degree, that is, the resistance to the discharge of the left ventricle is correspondingly diminished; whilst this discharge is accomplished much more frequently within a given time. In other words, the left ventricle, under the influence of Amyl Nitrite, has less work to accomplish, and liberates more force wherewith to accomplish it; that is, is greatly relieved. These considerations led Lauder Brunton to employ the drug in those cases of the complex class of disease known as angina pectoris in which agonising pain in the breast and neighbourhood is due to distension of the left ventricle, from its inability to empty itself against the pressure in the aorta, and in which fatal paralysis of the heart or rupture of its walls is the result of the unequal effort. Clinical experience has fully confirmed the value of Amyl Nitrite, in cases where spasm of the arteries is damming the blood back upon the ventricle, for the channels are instantly opened and the ventricle rapidly emptied by the double effect of the drug. The pain of aneurysm of the aorta and various forms of cardiac disease and disorder, especially those dependent on high arterial pressure, as in Bright's disease, can often be relieved by Amyl Nitrite, but caution

must be exercised in the first trial. Threatening death from cardiac paralysis in chloroform anæsthesia, and sea-sickness in which the blood pressure is greatly disturbed, are sometimes successfully treated with Amyl Nitrite. Some cases of epilepsy, accompanied by spasm of the cerebral vessels and facial pallor, and cases of megrim or sick headache due to similar spasm in the trigeminal area, are also benefited by this drug.

The reflex irritability of the cord is reduced (in animals) by Amyl Nitrite, which has therefore been proposed as a remedy in poisoning by strychnine. Neither the peripheral nerves nor the muscles are affected when it is given through the blood. Respiration is disturbed, apparently by the alteration of the hæmoglobin and circulation, not through the nervous system. The Nitrite sometimes affords immediate relief in asthma, but the dyspnœa may as quickly return. The body temperature falls, from obvious causes.

4. REMOTE LOCAL ACTIONS.

Amyl Nitrite probably escapes from the body by the urine, which is increased in amount and in acidity and may contain sugar. These effects are probably due to local disturbances of the circulation in the kidneys and liver respectively. The drug has been given to increase the elimination of uric acid in gout, and to acidulate the urine in phosphaturia.

Nitroglycerinum.—(*Not official in the uncombined form.*) TRINITROGLYCERIN. Trinitrin. "Glonoin." $C_3H_5[(NO_2)O]_3$.

Source.—Made by dropping Glycerin into a mixture of Sulphuric and Nitric Acids, kept cool by ice; separating by pouring the product into water; washing; and evaporating.

Characters.—A colourless oily liquid, odourless, with a sweet pungent taste. Sp. gr. 1·60. Slightly soluble in water; freely in fats, oil, alcohol, and ether. Highly explosive. A Nitrate of Glyceryl. Never used undiluted.

Preparations.

1. **Liquor Trinitrini.** — Solution of Trinitrin. Solution of Nitroglycerin. Trinitroglycerin of commerce, 1, by weight; alcohol 90 per cent., 100. 1 gr. in 110 minims. A clear colourless liquid; neutral. Sp. gr. 0·840. *Dose*, $\frac{1}{2}$ to 2 min.

2. Tabellæ Trinitrini.—Trinitrin Tablets. Tablets of Nitroglycerin. Tablets of Chocolate, each weighing 5 grains, and containing $\frac{1}{100}$ grain of the Trinitroglycerin of commerce. *Dose*, 1 or 2 tablets.

ACTIONS AND USES.

This substance closely **resembles in its action Amyl Nitrite** (p. 188); but it is more powerful, and its effects are more persistent if less rapidly produced. Its activity seems due to nitrous acid formed by its decomposition in the body, two-thirds of Nitroglycerin being reduced by an alkali, yielding a nitrite. It is used for the same class of cases as Amyl Nitrite —angina pectoris, chronic cardiac disease, sea-sickness, and asthma and other spasmodic disorders, some patients being more benefited by the one drug, some by the other, and the slower and more persistent action of Trinitrin being properly regarded.

Erythrol Tetranitrate.—(*Not official.*)

Source.—Formed by dissolving Erythrol in fuming nitric acid, and precipitating with sulphuric acid.

Characters.—Colourless crystals, nearly insoluble in water; explosive. *Dose*, $\frac{1}{2}$ to 2 gr. in tablets, with chocolate.

ACTIONS AND USES.

Erythrol Tetranitrate acts like the nitrites, but its effects, whilst less powerful, are much more prolonged. It is used to relieve high arterial tension or vasomotor constriction, as in nephritis and Raynaud's disease.

Formalin.—(*Not official*). Formaldehyde. H.COH. A colourless, pungent, neutral or faintly alkaline, 35 to 40 per cent. aqueous solution of Formic Aldehyde.

ACTIONS AND USES.

Formalin, being freely miscible with water, is a powerful **antiseptic, general disinfectant and deodorant.** Variously diluted, it has been used locally in infective diseases, and as a spray and intravenous injection in tuberculosis. Formalin possesses remarkable hardening properties, and is much employed as a preservative of museum specimens, the appearance of the preparations being unaltered in colour and shape.

Acidum Hydrocyanicum Dilutum.—Diluted Hydrocyanic Acid. "Diluted Prussic Acid." An aqueous solution containing 2 per cent. by weight of Hydrogen Cyanide, HCN.

Source.—Prepared by the interaction of Potassium Ferrocyanide and diluted Sulphuric Acid. $2K_4Fe(CN)_6 + 3H_2SO_4 = 6HCN + Fe_2K_2(CN)_6 + 3K_2SO_4$.

Characters.—A colourless liquid, with a peculiar penetrating odour. Sp. gr. 0·997. Faintly acid. Treated in succession with liquor potassæ and solutions of ferrous and of ferric sulphates, heated, and acidulated with HCl, it gives a green-coloured fluid, depositing Prussian blue. Treated with NH_4HS, and ferric chloride added after evaporation to dryness, it gives a deep blood-red colour. *Incompatibles.*—Salts of silver, copper, iron; red mercuric oxide and sulphides. *Dose*, 2 to 6 min.

Preparation.

Tinctura Chloroformi et Morphinæ Composita.—½ min. in 10 min. (1 in 20). See *Chloroformum.*

Hydrocyanic Acid is also contained in Aqua Laurocerasi (·1 per cent.). See also *Amygdala Amara*, page 285.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Applied for a time to the skin, Diluted Hydrocyanic Acid causes numbness, directly **depressing the sensory nerves.** It is used, largely diluted, to relieve itching, but must not be employed where the surface is raw from scratching, as it is readily absorbed from wounds.

Internally, it produces a peculiar sensation on the mouth and throat, and acts as a **sedative to the nerves of the stomach.** It is in common use to relieve gastric pain and arrest vomiting in painful dyspepsia, ulcer, and reflex or other nervous disorders of the stomach, *e.g.* in phthisis and pregnancy. The specific actions of the drugs on the medulla oblongata, to be presently described, doubtless assist its local effect upon the gastric nerves in producing these results.

2. ACTIONS ON THE BLOOD.

Hydrocyanic Acid enters the blood very rapidly from all parts, especially the lungs; and in poisonous doses produces an important change on the red corpuscles. It converts the blood of the veins first into a bright arterial colour, and then

into a deep black, the former change arresting the oxygenating function of the corpuscles, the latter destroying them. These effects of Hydrocyanic Acid on drawn blood must not be too readily supposed to occur in the circulating fluid within the body, where its actions in medicinal doses are chiefly local and specific.

3. SPECIFIC ACTIONS AND USES.

Hydrocyanic Acid rapidly enters the tissues, and acts chiefly upon the nervous structures. Considerable doses cause giddiness, faintness, nausea, a constricted feeling in the chest, headache, mental confusion, disturbed breathing, slowing of the pulse and muscular debility. Larger doses aggravate these symptoms, and produce great dyspnœa and other signs of asphyxia; whilst in still larger quantity it is familiar as one of the swiftest and deadliest of poisons. Analysis proves that this drug, whilst **depressing all nervous tissues**, acts first and chiefly upon the *respiratory centre*, which is briefly excited and then depressed, leading to weak respirations with long pauses, dyspnœa, convulsions, and finally death by asphyxia. Simultaneously, the afferent branches of the *respiratory nerves* are depressed, especially if the acid be inhaled; and reflex respiratory acts are arrested. The *vaso-motor centre* is temporarily stimulated, and the blood pressure rises, but it falls again suddenly and greatly. The *cardiac centre* is the most resistant of the three, but it also is depressed, so that the action of the heart becomes less frequent and less powerful. Although at the same time the nervo-muscular structures of the heart are depressed, the heart continues to beat in animals poisoned with Prussic Acid after the respiration and other functions have ceased. The *convolutions* are depressed, causing stupor which ends in unconsciousness; but this effect may be secondary to the disturbance of respiration. The *cord* is also lowered in activity. The peripheral *sensory nerves* are but little affected by the internal use of the drug, compared with its effect upon them locally. The *motor nerves* and *muscles* are depressed by repeated small doses of Diluted Hydrocyanic Acid, the influence extending downwards.

The chief specific use of this drug is to allay dry, useless cough, by its action on the respiratory centre and the afferent nerves in phthisis, pertussis and asthma. In phthisis it also checks the tendency to cough and vomit induced by food. As a cardiac sedative it is employed in the palpitation, pain and distress brought on by dyspepsia, where again it fulfils a double indication. Its general sedative effect on the nervous

system has suggested its use in epilepsy, chorea and tetanus, but with very doubtful benefit.

4. REMOTE LOCAL ACTIONS.

The mode of excretion of Hydrocyanic Acid is still obscure. Probably it escapes in part, as it enters in part, by the lungs; and some of it is supposed to be thrown out as ammonium formate.

Chloralamide.—(*Not official.*) Chloral Formamide. A compound of Chloral Anhydride and Formamide. $CCl_3CH{\cdot}OH{\cdot}NHCHO$.

Characters.—Colourless, shining crystals; inodorous; taste faintly bitter. *Solubility.*—1 in 20 of water; 1 in 2 of alcohol. Aqueous solutions are decomposed at 120° F., and by alkalis. *Dose*, 15 to 45 gr.

ACTIONS AND USES.

Chloralamide is a **hypnotic**—convenient, fairly certain and safe. It is therefore peculiarly valuable in the insomnia of cardiac disease and of certain nervous affections. It has also acted well in some cases of mania. Like most remedies for sleeplessness, its effects are very variable, even in the same patient. It appears not to lead to "habit." Chloralamide is not an anodyne. It may be given as a powder in broth or milk, in alcoholic solution, or in an enema.

Acidum Carbolicum. — PHENOL. C_6H_5OH. "CARBOLIC ACID."

Source.—Obtained from coal-tar oil by fractional distillation.

Characters.—Acicular crystals, colourless (or with a pinkish tinge if exposed to moist air); hygroscopic; with a peculiar odour, and sweetish pungent taste. Becomes and remains fluid on addition of 10 per cent. of water; melts at not lower than 102° F. to a liquid of sp. gr. 1·060 to 1·066. *Solubility.*—1 in 12 parts of water; freely in glycerin, chloroform, carbon bisulphide, benzol, ether, and alcohol 90 per cent.; in fixed and volatile oils, and in solutions of alkalis. Does not immediately redden blue litmus paper. Coagulates albumen and collodion, and liquefies camphor. Neutral solution of ferric chloride strikes a deep purple colour, and

bromine water gives a white precipitate, with a cold aqueous solution. Solutions of Ammonia and Chlorinated Soda produce a deep purple coloration. *Impurity.*—Aurin ($C_{19}H_{14}O_3$), or rosolic acid ($C_{20}H_{16}O_3$), which gives the purplish-red colour to Carbolic Acid when exposed, by absorption of carbonic acid and oxygen; cresol, giving turbidity with water. *Dose*, 1 to 3 gr.

Preparations.

1. **Acidum Carbolicum Liquefactum.**—Liquefied Phenol. "Liquefied Carbolic Acid."

Source.—Prepared by adding 10 (by weight) of water to 100 (by weight) of Phenol.

Characters.—A liquid, colourless at first, changing to pinkish; having the taste and odour of Phenol. Sp. gr. 1·064 to 1·069 at 60° F. Dissolves 18 to 27 per cent. of water at 60° F., yielding a clear solution. *Dose*, 1 to 3 min.

2. **Glycerinum Acidi Carbolici.** — Glycerin of Phenol. 1 to 5 of Glycerin, by solution.

3. **Suppositoria Acidi Carbolici.**—Phenol Suppositories. 1 gr. in each, with White Beeswax and Oil of Theobroma.

4. **Trochiscus Acidi Carbolici.**—Phenol Lozenge. 1 grain, with the Tolu Basis.

5. **Unguentum Acidi Carbolici.**—Phenol Ointment. 1 in 25, with Glycerin and Paraffin Ointment, White.

From Acidum Carbolicum are made:

6. **Sodii Sulphocarbolas.** — Sodium Sulphocarbolate. Sodium Phenol-para-sulphonate. $C_6H_4OH{\cdot}SO_2ONa,2H_2O$.

Source.—Obtained by dissolving Phenol in excess of Sulphuric Acid, and converting the phenolsulphonic acid so formed into a sodium salt.

Characters. — Colourless transparent rhombic prisms, nearly inodorous, with a saline and somewhat bitter taste. *Solubility.*—1 in 6 of water; 1 in 150 of alcohol 90 per cent.; the solutions are neutral. Ignition sets free phenol. *Dose*, 5 to 15 gr.

7. **Zinci Sulphocarbolas.**—Zinc Sulphocarbolate Zinc Phenol-para-sulphonate. $Zn(OH{\cdot}C_6H_4{\cdot}SO_3)_2,H_2O$.

Source.—Obtained by heating a mixture of Phenol and Sulphuric Acid, and saturating the product with Zinc Oxide.

Characters. — Colourless transparent, tabular, efflorescent crystals. *Solubility.*—1 in 2·5 of alcohol 90 per cent.; 1 in 2 of water. *Impurities.*—Other metals; acetates, chlorides and sulphates.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—The principal actions and uses of Phenol in disease depend upon its influence on fermentation and decomposition, which are intimately associated with many pathological processes. When this influence is studied apart from the body, we find that most *organised ferments* (yeast, moulds and bacteria) are readily deprived of their characteristic powers by solutions of Phenol; whilst *chemical ferments* (*enzymes*), such as pepsin and ptyalin, are much less readily affected. Although its effect on the *spores* of vegetable organisms is but small, a 5 per cent. solution being required to destroy them, its effect on fully developed microzymes is very great, a 1 per cent. aqueous solution certainly destroying the anthrax bacillus, and 1 part in 1000 being sufficient to prevent its growth. Phenol is thus an **antizymotic** (*anti*, against, *zume*, a ferment), and in the case of the zymosis of septic diseases, an **antiseptic.** At the same time the products of decomposition, which are generally infective and foul-smelling, are destroyed by the Phenol, which is therefore said to be **disinfectant** and **deodorant.** The exact *modus operandi* of the Phenol is still obscure, as are also in some respects the nature of the fermentative processes and the relation of organisms to them. Be the explanation what it may, the power of Phenol, or of any substance which can thus arrest molecular processes universally at work in physiology and pathology, must be regarded as enormous, both in itself and in its effects.

Phenol is extensively employed in the **antiseptic** method of the treatment of wounds, ever associated with the name of Lord Lister, who introduced it. A 5 per cent. solution in water serves to cleanse instruments, and to wash the skin of the part before operation. A $2\frac{1}{2}$ per cent. aqueous solution is used to purify sponges and the hands of the operator, and as a lotion. Dissolved in olive oil 1 to 10, 1 to 20, 1 to 50 or still weaker, or as 1 part of Phenol with 7 parts of Castor Oil and 8 of Almond Oil, it is used for lubricating catheters, or as a special dressing; but the value of these oily compounds is very doubtful, as they have been found to have no influence

on germs. Carbolic Acid Gauze consists of unbleached cotton gauze medicated with half its weight of a mixture of Phenol (1), Resin (4) and Paraffin (4). Liquefied Phenol is a convenient form for general use. Zinc Sulphocarbolate is also used as a disinfectant and antiseptic.

Coming to its physiological action proper on the human tissues, we find that Phenol is a local irritant to the skin, causing a momentary sense of burning followed by anæsthesia, and finally a caustic effect with formation of a hard white eschar. It may therefore be applied to poisoned wounds and foul ulcers; and in dilute solutions (1 to 40) is a **stimulating** as well as disinfectant wash to wounds and discharging mucous surfaces or cavities, in the form of a lotion, injection, or gargle. It also relieves itching, especially in cases where a strong solution (1 in 20) can be applied, *i.e.* where the skin is not inflamed. It is used with success in ringworm, where it destroys the vegetable organisms.

Apart from the body, Phenol is extensively used as a **general disinfectant,** to disinfect stools, flush drains, etc.

Internally.—In the form of vapour, Phenol is stimulant and disinfectant, and is used in ulceration of the throat and lungs—phthisis, dilated bronchi, gangrene, etc. In the stomach and bowels it is a powerful irritant poison in large doses; in moderate quantity, or as the Sulphocarbolates, it arrests fermentation in gastric dilatation, obstinate vomiting, and some kinds of diarrhœa. Two other points may be noted in this connection: first, that Phenol unites with sulphates to form sulphocarbolates, which suggests the use of soluble sulphates as antidotes in poisoning by the drug; second, that Phenol is a natural product of the action of the pancreatic ferment on proteids.

2. Actions in the Blood.

Phenol is rapidly absorbed from the unbroken skin, mucosæ, wounds, subcutaneous tissues, respiratory passages and stomach; and for a considerable time can be found in the blood unchanged. Here it steadily disappears, by conversion into compounds from which it may be again derived; uniting, for example, with sulphates, as already described. The blood is dark, and slow to coagulate, after poisoning by the drug.

3. Specific Actions and Uses.

The actions of Phenol on the organs are of little interest to the therapeutist. It is found in them chiefly as phenol-yielding compounds; and its effects in large doses are chiefly those of a sedative poison. The heart first falls and then

rises in frequency, from disturbance of the cardiac centre. The blood-pressure rises at first, returns to the normal, and falls after a fatal dose. Dyspnœa ensues, also central in origin; and coma supervenes. In the lower animals convulsions occur through the cord; then paralysis and collapse. The voluntary muscles are not affected by Phenol, but the pupil is contracted. Sensibility is not reduced by internal administration of the drug. The temperature falls slightly after medicinal doses, but may rise in cases of dangerous absorption from dressings. Phenol and the Sulphocarbolates have been given internally in fevers, and with success in some cases of ulcerative endocarditis. Phenol may temporarily relieve diabetes mellitus.

4. REMOTE LOCAL ACTIONS.

Phenol and its products rapidly leave the body, chiefly by the urine. But little of it can be recovered unchanged, for (1) part is lost in the system, being probably converted into oxalates and carbonates; (2) part appears as sulphocarbolic acid in combination; (3) part is constituted by an obscure compound; and (4) the remainder appears to give rise to a peculiar olive-green, brown, or grey discoloration of the urine, probably due to a compound of hydrochinon, $C_6H_4(HO)_2$, which is familiar to surgeons. It is important to note that this change in the urine bears no definite relation to the amount of Phenol in the blood, nor to the danger of poisoning. Fainting and collapse, with or without rise of temperature, are the principal symptoms of its excessive absorption from a wound or through the skin. Disappearance of the sulphates from the urine, easily ascertained by ordinary tests, is a sure indication of danger. Albuminuria is sometimes induced.

Phenol also leaves the body by the saliva, which is increased; and it stimulates the flow of sweat, although it is not found in it.

Salol.—Salol. Phenyl Salicylate. $C_6H_4{\cdot}OH{\cdot}COO{\cdot}C_6H_5$.

Source.—Prepared by the interaction of Salicylic Acid and Phenol, or of their Sodium Salts with Phosphoryl Chloride or Carbonyl Chloride.

Characters.—Colourless crystals, with faint aromatic odour and very little taste. *Solubility.*—1 in 10 of cold alcohol 90 per cent. (solution neutral); 3 in 1 of ether or

chloroform; and in fixed and volatile oils; insoluble in water. *Impurities.*—Free salicylic acid, sulphates and chlorides.

Dose.—5 to 15 gr. (in milk or in cachets).

ACTIONS AND USES.

Salol combines in most respects the actions of phenol and salicylic acid. *See* page 196, and page 388.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally applied, Salol is **disinfectant,** but is little employed.

Internally, it is not decomposed in the stomach; and for this reason it is an active **disinfectant in the intestine,** where it is broken up by the pancreatic ferments into Salicylic Acid and Phenol. Salol is extensively used in enteric catarrh, appendicitis, typhoid fever, and other diseases of the bowels attended with inflammation, ulceration, and foulness of their products and of the intestinal contents.

2. ACTIONS ON THE BLOOD, AND SPECIFIC ACTIONS AND USES.

The constituents of Salol pass through the blood into the tissues and organs, where they produce their specific effects respectively. The drug is a powerful **antipyretic,** which sometimes proves useful in acute rheumatism and rheumatic affections of different forms, such as pharyngitis, when Salicin and Sodium Salicylate fail, as they occasionally do. It is also anodyne or **analgesic,** like Sodium Salicylate. In large doses Salol produces the same unpleasant effects on the organs as the other salicyl compounds, including deafness, tinnitus aurium, vomiting and depression.

3. REMOTE LOCAL ACTIONS AND USES.

Salol is slowly excreted as sulphocarbolic acid and salicylic acid by the different eliminating organs. Escaping by the kidneys, it disinfects their secretion when ammoniacal, and also the mucous surfaces of the genito-urinary tract; but it is apt to colour the urine green and black, and it must also be used with caution in renal disease, as it may produce acute hyperæmia of the kidneys. This drug may also give rise to profuse sweating and morbilliform eruptions.

Resorcin.—(*Not official.*) $C_6H_4(HO)_2$.—Derived from Phenol or from benzene by various processes.

Characters.—White tabular lustrous crystals, with a weak odour like Phenol, and a sweetish, pungent taste. *Solubility.*—1 in 1 of water; 1 in 20 of olive oil; 2 in 1 of alcohol. *Dose*, 3 to 8 gr.

ACTIONS AND USES.

Resorcin is **antiseptic and disinfectant** without being irritant in 2 to 10 per cent. solutions. It is used in some forms of chronic epithelial thickening, as ointments, pastes, etc. Internally it is **antipyretic.**

Piperazine.—(*Not official*). DIETHYLENE-DIAMINE. $C_2H_4{\cdot}NH_4{,}NH_4{\cdot}C_2H_4$. An organic base prepared by the interaction of sodium glycol on ethylene-diamine hydrochloride.

Characters. — Small colourless deliquescent crystals, strongly alkaline, with faint odour and saline taste. *Solubility.*—About 4 in 7 of water. *Dose*, 4 to 10 gr.

ACTIONS AND USES.

Piperazine is a powerful **solvent of uric acid,** outside the body, producing a comparatively soluble urate; but in the body it does not increase the amount of the acid excreted. It has been given in uric acid gravel and calculus, without apparent success. In gout it is of doubtful value, as it does not influence urates either in the plasma or in the tissues.

Glusidum.—GLUSIDE. Glucusimide. "Saccharin," Benzoyl Sulphonimide. $C_6H_4\begin{<}{CO}{SO_2}\end{>}NH$. A sweet imide derivable from the toluene of coal tar.

Characters.—A light white, minutely crystalline powder; odourless; taste intensely sweet in dilute solutions. *Solubility.*—1 in 400 of cold water, 1 in 24 of boiling water; 1 in 25 of alcohol 90 per cent.; slightly in ether or chloroform; very readily in diluted Solution of Ammonia; also in solution of sodium bicarbonate, evolving CO_2, and yielding "soluble

gluside" or "soluble saccharin" on evaporation, which is very soluble in water. *Impurities.*—Sugar; Sulphamido-benzoic acid.

ACTION AND USE.

Gluside is used as a **sweetening agent** to cover the taste of nauseous drugs, as well as in diabetes mellitus and hepatic disorders. It is not a food.

Sulphonal. — DIMETHYL - METHANE - DIETHYLSUL - PHONE. $(CH_3)_2C(SO_2C_2H_5)_2$.

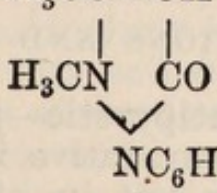
Source.—May be obtained by oxydising Mercaptol $(CH_3)_2C(SC_2H_5)_2$, prepared from Acetone and Mercaptan.

Characters.—Colourless prismatic crystals, odourless, nearly tasteless; neutral. *Solubility.*—1 in 450 of cold, 1 in 15 of boiling, water; 1 in 50 of cold alcohol 90 per cent.; soluble in ether. *Dose*, 10 to 30 gr.

ACTIONS AND USES.

Sulphonal is a **hypnotic,** producing lengthened and refreshing sleep. As it is tasteless, and does not derange digestion, nor seriously depress the circulation or respiration, it may be safely ordered in diseases of the heart and lungs where Morphine and Chloral are contra-indicated. But it is somewhat slow and uncertain, and may cause prolonged drowsiness, giddiness and eruptions. It is a valuable hypnotic in insanity with excitement. As the dose often has to be increased, and the use of it prolonged, a Sulphonal habit may be established, with serious after-effects. Hæmatoporphyrinuria has followed its administration, with associated symptoms of physical debility or nervous paresis. A single large dose may be poisonous. It is best given as a fine powder in hot broths some hours before bedtime.

Phenazonum.—PHENAZONE. "Antipyrine." Phenyl-dimethyl-iso-pyrazolone.



Source.—Obtainable from phenyl-hydrazine by interaction with aceto-acetic ether and the subsequent interaction of the resulting phenyl-methyl-iso-pyrazolone with methyl iodide.

Characters.—Colourless, scaly crystals; odourless; taste bitter. Melts about 235·4° F. *Solubility.*—1 in 1 of water; 1 in 1⅓ of alcohol 90 per cent., or of chloroform; 1 in 40 of ether. Aqueous solution neutral. *Incompatibles.*—Spiritus Ætheris Nitrosi (a bluish green colour being formed), and other nitrites; the alkaloids of Cinchona. *Dose*, 5 to 20 gr.

ACTIONS AND USES.

Phenazone is a very powerful **antipyretic** and a **general nervous sedative and anodyne.** It quickly reduces the temperature in fever, the defervescence beginning within the first hour. It decidedly controls the pyrexia of most of the acute specific diseases and tuberculosis, at the same time relieving discomfort; but it is not to be employed in a routine fashion. It is less useful in ague and rheumatism. Free perspiration, and occasionally sickness and erythematous eruptions, attend the use of Phenazone. Fatal collapse has been produced by excessive doses. As an anodyne, it often gives prompt and complete relief in megrim, neuralgia, locomotor ataxy, gout and rheumatism. If it disagree with the stomach, it may be given either subcutaneously as a 5 per cent. solution, or by the rectum. The addition of a few drops of spirit of peppermint disguises its taste.

Acetanilidum.—ACETANILIDE. Phenyl-acetamide. $CH_3{\cdot}CO{\cdot}NH{\cdot}C_6H_5$. "Antifebrin."

Source.—Obtainable by the interaction of Glacial Acetic Acid and aniline.

Characters. — Colourless, glistening, lamellar crystals; odourless; taste slightly pungent; melts at 236·5° F. *Solubility.*—1 in 200 of cold, 1 in 18 of boiling, water; 1 in 4 of alcohol 90 per cent.; freely in ether, chloroform and benzol. *Impurities.*—Free acid, acetone, phenazone and salts of aniline. *Dose*, 1 to 3 gr. (in wine or diluted spirit, or in cachet, or with Pulvis Tragacanthæ Compositus).

ACTIONS AND USES.

Acetanilide is an **antipyretic**—powerful, safe and convenient (except for its comparative insolubility in water). It quickly reduces pyrexia, but its effect is evanescent. It is also a **nervous sedative**, which has been given in neuralgia, megrim, tabes dorsalis and allied affections.

Phenacetinum.—Phenacetin. Para-acet-phenetidin. $C_2H_5O{\cdot}C_6H_4{\cdot}NHCOCH_3$.

Source.—Produced by the interaction of Glacial Acetic Acid and para-phenetidin, a body obtained from para-nitrophenol.

Characters.—White glistening scaly crystals; odourless; tasteless, neutral. *Solubility.*—Very sparingly in cold, more freely in boiling, water; 1 in 20 of alcohol 90 per cent. Melts at 275° F. *Impurities.*—Acetanilide and para-phenetidin. *Dose*, 5 to 10 gr.

ACTIONS AND USES.

Phenacetin is **antipyretic, anodyne and hypnotic**, like Phenazone and Acetanilide. It is comparatively safe and lasting in its effects; and has been used in many pyrexial diseases and neuralgic affections with some success, as well as in tabes dorsalis.

Naphthol.—Beta-naphthol. Beta-mono-hydroxy-naphthalene. $C_{10}H_7OH$.

Source.—Is usually prepared from naphthalene-sulphonic acid.

Characters.—White, or nearly white, crystalline laminæ, or in powder, with an odour of phenol, and a sharp, pungent taste. Neutral. *Solubility.*—1 in 1000 of cold, 1 in 75 of boiling, water; in less than 2 of cold, very soluble in boiling, alcohol 90 per cent., ether, chloroform, or solution of sodium hydroxide; also soluble in olive oil or benzol. *Impurities.*—Alpha-naphthol, mineral matter. *Dose*, 3 to 10 gr.

ACTIONS AND USES.

Naphthol is a powerful **antiseptic and disinfectant**. It has been used as an external and internal disinfectant, much like Iodoform. Internally it is prescribed in cachets or pills, as an **intestinal disinfectant**, particularly in typhoid fever, cholera, diarrhœa and dysentery. Its action on the contents of the bowel is purely local, most of the dose being recoverable from the fæces, whilst the traces which are absorbed are excreted also unchanged in the urine. Beta-naphthol is applied, as ointment or solution (5 to 15 per cent.), in some diseases of the skin such as hyperidrosis, scabies, and psoriasis, instead

of Tar, which it closely resembles in its action, whilst it possesses the advantage of having a less unpleasant odour.

Creosotum.—CREOSOTE. *Source.* — Obtained in the distillation of Wood Tar.

Characters.—A colourless or yellowish, highly refractive liquid, with a strong empyreumatic odour and acrid taste; neutral or faintly acid. *Solubility.*—1 in 150 of cold, more so in hot, water; freely in alcohol 90 per cent., ether, chloroform, glacial acetic acid and glycerin. Sp. gr. not below 1·079. Distils between 392°–428° F. Lævorotatory. *Impurities.*—Phenol; detected by becoming solidified on cooling. Less volatile liquids. *Incompatible.*—Oxide of Silver.

Composition.—Creosote is not a simple body, but a variable compound of *guaiacol* $C_7H_8O_2$, *creosol* $C_8H_{10}O_2$, and other phenols. Guaiacol may amount to 20 per cent. in good specimens of Creosote. Chemically pure (as prepared synthetically from pyrocatechin) it occurs as colourless prismatic crystals, with a more agreeable odour and taste than Creosote; melting at 83° to 91° F.; and soluble in alcohol, ether, fats, oils and glycerin, and slightly in water.—**Guaiacol Carbonate** is a convenient combination of this body, which constitutes 91·5 per cent. of it. It is a minutely crystalline white substance, with no taste and but slight odour; insoluble in water, soluble in alcohol; given in doses of 3 to 10 gr.

Dose.—1 to 5 min. (with mucilage, almond or cod-liver oil, or with milk).

Preparations.

1. **Mistura Creosoti.**—Creosote Mixture. Creosote, 1; Spirit of Juniper, 1; Syrup, 30; Distilled Water, 480. 1 min. in 1 fl.oz. nearly. *Dose*, ½ to 1 fl.oz.

2. **Unguentum Creosoti.**—Creosote Ointment. 1; Hard Paraffin, 4; Soft Paraffin, White, 5.

ACTIONS AND USES.

Externally, the actions of Creosote are, practically speaking, similar to those of Phenol (*see* page 196); but its characters and the uncertainty of its composition and strength, as a complex product, interfere with its general employment as an **antiseptic.** The Ointment is employed in dry skin diseases. Guaiacol painted on the skin has a remarkable action in reducing the temperature in fever by several degrees,

with free perspiration but unfortunate depression of the heart. This effect of the drug is not employed therapeutically.

Internally, as an inhalation (12 min. in 8 fl.oz. of boiling water) or given in capsule, Creosote is a **disinfectant and deodorant** in tuberculosis, chronic bronchitis, gangrene and other diseases of the lungs attended with foul discharges. Guaiacol or its Carbonate has now come into general use for this purpose, instead of the crude drug; and is intended as a specific in tuberculosis, for which it is given continuously over long periods of time. The Carbonate is best given in cachet. A combination of Creosote, Iodine, and various volatile substances such as Ether, Chloroform, and Alcohol, has become popular as a constant inhalation in phthisis. The Mistura Creosoti is intended chiefly as a remedy in vomiting due to pyloric obstruction, dilatation of the stomach and consequent fermentation. The special value of the drug in this class of cases depends on the fact that whilst it readily destroys low vegetable organisms, such as torulæ and sarcinæ, and arrests the fermentations with which they are associated, it does not interfere with the action of pepsin and the digestive process. It occasionally proves useful in vomiting from other causes, and in some forms of diarrhœa due to bacterial decomposition in the intestine.

Pix Carbonis Præparata.—Prepared Coal Tar.

Source.—Prepared by placing commercial Coal Tar in a shallow vessel, and maintaining it at 120° F. for one hour, stirring frequently.

Preparation.

Liquor Picis Carbonis.—Solution of Coal Tar. Made by adding Prepared Coal Tar to an alcoholic percolate of Quillaia Bark, digesting the mixture at 120° F. for two days, occasionally stirring, cooling and decanting or filtering.

ACTIONS AND USES.

The actions and uses of Coal Tar are similar to those of Wood Tar. *See* page 405.

Iodoformum.—Iodoform. Tri-iodomethane. CHI_3.

Source.—Produced by the action of Iodine on Ethylic

Alcohol in the presence of solution of Potassium Carbonate. $C_2H_6O + 4I_2 + 3K_2CO_3 = CHI_3 + KCHO_2 + 5KI + 2H_2O + 3CO_2$.

Characters.—Small, shining, lemon-yellow hexagonal crystals, somewhat unctuous to the touch; with a powerful and persistent saffron-like odour, and an unpleasant taste. *Solubility.*—Very slightly in cold water; 1 in 80 of cold, 1 in 10 of boiling, alcohol 90 per cent.; 1 in 5 of cold ether; also in chloroform, carbon bisulphide, or fixed and volatile oils; sparingly in benzol. The solutions are neutral. It contains more than 90 per cent. of iodine. *Impurities.*—Soluble yellow colouring matters, picric acid, iodides, etc.

Dose.—$\frac{1}{2}$ to 3 gr.

Preparations.

1. **Suppositoria Iodoformi.** — Iodoform Suppositories. 3 gr. in each, with 12 gr. of Oil of Theobroma.

2. **Unguentum Iodoformi.** — Iodoform Ointment. 1 in 10, with Paraffin Ointment, yellow.

(*Not official.*) Iodoform Wool. Absorbent Cotton Wool, containing 10 per cent. of Iodoform.—Iodoform Gauze, etc.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Iodoform is an **antiseptic and disinfectant,** but destroys organisms less readily than Phenol. It is a very powerful deodorant. When applied to the human tissues, it produces little or no irritation; indeed, it is a **local anæsthetic.**

Iodoform is used to cleanse foul ulcers, especially of venereal origin; and may possibly have a special effect on strumous ulceration. It has also been extensively applied as **an antiseptic** dressing to healing wounds, the best forms being the drug reduced to powder for dredging on the part, Iodoform Wool and the Ointment. Sometimes Iodoform Gauze has been employed. A powder of Iodoform diluted with Quinine or Bismuth Oxynitrate is a valuable insufflation in ozæna and ulcers of the mouth and throat.

2. ACTIONS IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

Iodoform is occasionally absorbed from wounds, and causes an erythematous punctiform or eczematous eruption, attended with serious constitutional disturbances, including sickness and fever, with restlessness and delirium in some

subjects, drowsiness and collapse in others. Iodine is possibly set free in the blood or tissues, and appears in the urine in part as sodium iodide. Iodoform has been used in an endless variety of diseases internally, *e.g.* as an intra-venous injection in tuberculosis, but with questionable benefit.

Paraffinum Durum.—Hard Paraffin. A mixture of several of the harder members of the Paraffin series of hydrocarbons.

Source.—Usually obtained by distillation from shale, separation of the liquid oils by refrigeration, and purification of the solid product.

Characters.—Colourless, semi-transparent, crystalline, inodorous and tasteless, slightly greasy to the touch. Sp. gr. 0·82 to 0·94. *Solubility.*—Insoluble in water; slightly soluble in absolute alcohol; almost entirely in ether. Melts at 130° to 135° F., and burns with a bright flame, leaving no residue.

Preparation.

Unguentum Paraffini.—Hard Paraffin, 3; Soft Paraffin, 7.

Unguentum Paraffini is used in preparing many Ointments.

Paraffinum Durum is used in preparing many Ointments.

Paraffinum Molle.—Soft Paraffin. "Vaselin." A semi-solid mixture containing soft members of the Paraffin series of hydrocarbons.

Source.—Usually obtained by purifying the less volatile portions of petroleum.

Characters.—*White* or *Yellow*, translucent, soft, unctuous to the touch; free from acidity, alkalinity, or any unpleasant odour or flavour, even when warmed to 120° F. Sp. gr. at melting-point (96° to 102° F., or somewhat higher), 0·840 to 0·870. Burns with a bright flame, leaving no residue. *Solubility.*—Slightly in absolute alcohol; freely in benzol, chloroform and ether; insoluble in water. *Impurities.*—Fixed oils, fats and resins.

Paraffinum Molle is contained in many Ointments.

Paraffinum Liquidum.—Liquid Paraffin.

Source.—Obtained from petroleum after the removal of the more volatile portions by distillation.

Characters.—A clear, oily, non-fluorescent liquid; colourless, odourless, and tasteless. Boiling-point not below 680° F. Sp. gr. 0·885 to 0·890. *Impurities.*—Acids; Sulphur compounds.

ACTIONS AND USES.

Paraffin cannot become rancid or irritant to the skin, and being readily miscible with many active substances, is indicated instead of Lard as a valuable **basis for ointments** intended to produce a *local* effect, especially those of Mercury, Lead, and Zinc, as well as of non-metallic antiseptics and disinfectants. As it appears to be absorbed but very slightly by the skin, like fats, it is unfitted as a basis for the application of drugs when they are intended to enter the system and produce their specific action, such as some mercurials and alkaloids. The hard form is useful because of its high melting-point and consequent freedom from tendency to spread through the dressings. Liquid Paraffin is used as a solvent for Menthol, Cocaine and other drugs when applied in the form of spray. Petroleum has also been given internally, but appears not to be absorbed.

Benzol.—BENZOL. *Source.*—Light coal-tar oil.

Characters.—A colourless volatile liquid, free from opalescence, with a strong characteristic odour.

Composition.—A mixture of homologous hydrocarbons. It contains about 70 per cent. of benzene, C_6H_6, and 20 to 30 per cent. of toluene, C_6H_5,CH_3.

USE.

In preparing Charta Sinapis and Liquor Caoutchouc.

Hexamethylen-tetramine.—(*Not official.*) $(CH_2)_6N_4$. "UROTROPINE." Obtained by the action of Ammonia on Formic Aldehyde.

Characters.—Colourless granular crystals, alkaline, readily soluble in water. *Dose* 10 to 15 gr. (in cachet).

ACTIONS AND USES.

Urotropine is excreted, partly unchanged, in the urine, and acts as a powerful disinfectant in diseases of the kidneys and bladder associated with bacterial decomposition of urine. It is a valuable drug in pyelitis and cystitis; and is also diuretic and possibly a solvent of uric acid.

Trional. — (*Not official*). DI-ETHYL - SULPHONE-METHYL-ETHYL-METHANE. $\begin{matrix}CH_3\\C_2H_5\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}SO_2\ C_2H_5\\SO_2\ C_2H_5\end{matrix}$

Characters.—In small shining crystals; with a bitter, not unpleasant taste; inodorous. *Solubility.*—1 in 320 of water, freely in alcohol (90 per cent.). *Dose*, 5 to 30 gr. (in cachet or in warm milk or broth).

ACTIONS AND USES.

Trional is a safe and efficient **hypnotic**, closely resembling its allied sulphone, Sulphonal, but less slow. It has been prescribed in mental diseases and in neurasthenic conditions, particularly in the insomnia associated with overwork. It is useless in painful states. Trional does not derange digestion.

Veronal.—(*Not official*). DI-ETHYL-MALONYL-UREA. $C_8H_{12}N_2O_3 = \begin{matrix}C_2H_5\\C_2H_5\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}CO—NH\\CO—NH\end{matrix}\!\!>\!CO$

Characters.—Small white crystals, odourless, taste slightly bitter. *Soluble* in 145 parts of water at 20° C. *Dose*, 5 to 25 grs. in cachet or dissolved in warm tea (not in milk).

ACTIONS AND USES.

Veronal is a powerful hypnotic, producing within half an hour to an hour quiet, dreamless and refreshing sleep. It possesses the advantages of causing no disturbance of the visceral functions; the heart, vessels, respiration, kidneys and body-temperature being said to remain primarily unaffected even by full and repeated doses. It has been found to be specially useful in the insomnia of neurasthenia, mental disorder, morphinism and alcoholism; and to be safely employed in cardiac and renal diseases. It does not relieve pain.

Aspirin.—(*Not official*). Acetic ester of Salicylic Acid $C_6H_4\!<\!\!\begin{matrix}O\text{-}CO\ CH_3\\C\ O\ O\ H\end{matrix}$

Characters. — A white crystalline inodorous powder. *Soluble* in alcohol, ether, and glycerin; almost insoluble in water. *Dose*, 10 to 15 gr. (in cachet).

ACTIONS AND USES.

Aspirin passes almost undecomposed through the stomach, which is therefore but little irritated by it. Its molecular

constituents begin to be liberated when it meets the alkaline fluids of the duodenum, where they are absorbed slowly, along with the part of the Aspirin which is still unchanged and which is then broken up in the blood and the tissue-lymph. Thus the drug enters the system by degrees, and, its products being slowly excreted, its **antipyretic and specific** actions, which closely resemble those of Salicylic Acid, are relatively more gradual and more prolonged (p. 389), whilst it does not depress the heart so readily. To secure these effects, it must not be prescribed along with alkalis. Aspirin is used as a substitute for the Salicylates and Salicin, particularly in articular or other forms of rheumatism, in gouty and some other kinds of arthritis, and in myalgia, neuritis, migraine and influenza. It appears to be more useful than Sodium Salicylate in relieving the pains of osteo-arthritis.

Æthyl Chloridum. — (*Not official*). ETHYL CHLORIDE. C_2H_5Cl. A colourless mobile liquid, with a sweetish burning taste. *Solubility.*—Sparingly in water, readily in alcohol. Sp. gr. ·921. Its vapour is inflammable. The average *dose* for an adult is 5 c.c., and for a child 3 c.c., by inhalation.

ACTIONS AND USES.

Ethyl Chloride is employed as a **general anæsthetic** for operations of short duration but where the anæsthesia required is longer than can be obtained by Nitrous Oxide, and also for cases in which the administration of Ether is undesirable. Two minutes' anæsthesia can generally be relied upon. It is also used in place of Nitrous Oxide previous to Ether and Chloroform administration; and in the case of the latter it shortens the period of induction.

Ethyl Chloride cannot compare with Nitrous Oxide in safety, and headache and sickness are far more prevalent after its use; so that Nitrous Oxide or Nitrous Oxide-and-Oxygen is the routine anæsthetic for ordinary dental extractions, and Ethyl Chloride is reserved for difficult cases.

Citarin. — (*Not official*). ANHYDROMETHYLENE SODIUM CITRATE. $2\,(CH_2—COONa)\,(CO{\cdot}CH_2\,COO)$.

Characters.—A white crystalline powder, with a slightly alkaline not unpleasant taste. *Solubility.*—1 in 1 of water; almost insoluble in alcohol and ether. *Dose.*—30 gr. several times a day.

ACTIONS AND USES.

Citarin, a product of the reaction of Formaldehyde upon sodium citrate, is split up in the blood, and liberates the formaldehyde, which **unites with uric acid** and forms a combination readily excreted in the urine. The sodium citrate is further **antacid and diuretic** (p. 149). The drug sometimes causes diarrhœa. Citarin is used in acute and chronic gout, and in uric acid gravel and calculus, apparently with some success

Part II.

THE ORGANIC MATERIA MEDICA

GROUP I.

THE VEGETABLE KINGDOM

RANUNCULACEÆ.

Aconiti Radix.—ACONITE ROOT. The root of Aconitum Napellus, collected in the autumn from plants cultivated in Britain, and dried.

Characters.—Usually from 2 to 4 inches long, ½ to ¾ inch thick at the crown; conical; brown; presenting scars or bases of broken rootlets. Fracture short; whitish and starchy within. Has no marked odour. Cautiously chewed, causes tingling and prolonged numbness in the mouth.

Composition.—The active constituent of Aconite is an alkaloid, *aconitine* ($C_{33}H_{45}NO_{12}$), in colourless hexagonal rhombic prisms; very sparingly soluble in water and in petroleum spirit, readily in alcohol 90 per cent. or chloroform, less readily in ether. Even a very dilute solution causes characteristic tingling and prolonged numbness of the tongue and lips. *Benzaconine*, $C_{24}H_{38}(C_6H_5CO)NO_{10}$, *Aconine*, $C_{24}H_{39}NO_{10}$, and other more or less allied alkaloids, occur along with it. They are combined with a peculiar acid, *aconitic acid*.

Preparations.

1. **Tinctura Aconiti.**—1 in 20 of Alcohol 70 per cent.; by percolation. *Dose*, 5 to 15 min.; if very frequently repeated, 2 to 5 min.

2. Linimentum Aconiti.—1 in 1·5 of Alcohol 90 per cent., by percolation; with $\frac{1}{20}$ of Camphor.

From Aconiti Radix is made:

3. **Aconitina.**—Aconitine, $C_{33}H_{45}NO_{12}$, an alkaloid obtained from Aconite Root.

Characters.—See *Composition of Aconite Root.*

Not given internally.

Preparation.

Unguentum Aconitinæ.—0·5; dissolved in Oleic Acid, 4; added to Lard, 20·5.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Applied to the skin, or an exposed mucous membrane, Aconite affects the terminations of the sensory nerves, causing tingling followed by numbness, and **lowering the sensibility** of touch and temperature. It is, therefore, used to relieve pain due to disorder of the peripheral nerves, particularly certain forms of neuralgia and acute and chronic rheumatism. The Aconitine Ointment must be employed with great caution, especially in the neighbourhood of the eye.

Internally.—A drop of even an extremely dilute solution of Aconitine (not more than one-tenth per cent.) causes persistent tingling and numbness of the tongue and lips. A sense of warmth and pain and sickness follows its admission to the stomach in full doses.

2. ACTIONS IN THE BLOOD; SPECIFIC ACTIONS AND USES.

Aconitine enters the blood, and thence finds its way to the tissues. Medicinal doses of Aconite, taken in close succession, **reduce the frequency, force, and tension of the pulse; flush and moisten the skin; and increase the amount of urine.** Larger doses cause a sense of illness and muscular weakness; "creeping," "tingling," "numb" sensations generally, but especially in the lips, face and extremities, ending in anæsthesia; and disturbances of vision, hearing and consciousness. On analysis, it is found that the heart is briefly accelerated, and then reduced in frequency by Aconitine, through the nerves; its force is then reduced, by direct action on the nervo-muscular structures; and finally the cardiac action becomes greatly accelerated, irregular and more and more feeble, tending to cease in diastole. The blood-pressure falls continuously, partly from cardiac, partly

from vaso-motor depression. On the contrary, Aconine and Benzaconine act to some extent as the antagonists of Aconitine, slowing the heart; the former is indeed a general cardiac tonic. Respiration is slowed and deepened by Aconitine and Benzaconine, with spasmodic irregularity of rhythm, and is finally arrested after poisonous quantities: **death is due to central respiratory failure.** The skin is stimulated, perspiration becoming abundant. The kidneys are also stimulated, both the fluids and solids of the urine being increased in amount. Oxydation being diminished both directly and through impairment of circulation and respiration, **the temperature falls steadily.** The muscular weakness appears to be primarily due to depression of the motor nerve-endings; but this condition extends to the cord. The brain itself is not directly affected; and even in cases of poisoning by Aconite, consciousness, although disturbed, is preserved almost to the end. The sensory nerves are probably paralysed from their periphery inwards by the internal, as by the external, administration of the drug.

Such being the specific actions of Aconite, the use of it is obviously indicated in the treatment of two morbid conditions, namely, **fever** and **pain.** The cardio-vascular excitement, the dry skin, the high temperature and the scanty secretions of fever would all be relieved by this drug. For this purpose the Tincture is given in small and closely repeated doses, say 1 minim in water every 15, 20, or 30 minutes, the effect being watched. Acute tonsillitis, bronchitis, pleurisy, and febrile conditions attending other local inflammations, have been treated with Aconite, the effect being to control the urgent symptoms, relieve the distress of the patient, and possibly to cut short the disease. Some of the symptoms of scarlatina and measles may be similarly alleviated. The powerfully depressant action of Aconite on the respiration and the circulation forbids its use as an antipyretic in diseases of the lungs and heart, and suggests its cautious employment in all cases.

In neuralgia and other painful affections connected with the nerves and muscles, Aconite may be given internally instead of being locally applied; facial neuralgia with spasm (*tic-douloureux*) particularly being relieved by it. In these cases, also, the Tincture might be given in minim doses, repeated three or four times in an hour, and the effect watched.

3. REMOTE LOCAL ACTIONS AND USES.

Aconite is probably excreted by the kidneys, and as we have seen, increases the activity of their secretion. The

stimulation of the sweat glands and the occasional appearance of an eruption suggest that it also leaves the body by the skin.

Staphisagriæ Semina. — Stavesacre Seeds. The dried ripe seeds of Delphinium Staphisagria.

Characters.—Irregularly triangular or obscurely quadrangular, arched, blackish-brown when fresh, dull greyish-brown by keeping. Testa wrinkled and deeply pitted; interior soft, whitish, oily. No marked odour; taste nauseous, bitter and acrid.

Composition.—Stavesacre contains four alkaloids, *delphinine*, allied to aconitine; *staphisagrine*, *delphinoidine* and *delphisine*.

Preparation.

Unguentum Staphisagriæ.—2, crushed; Benzoated Lard, 8·5; Yellow Beeswax, 1.

ACTIONS AND USES.

Delphinine closely resembles Aconitine in its actions, but is even more depressant to the vessels. Stavesacre is used only as a **parasiticide** in the form of the Ointment, to kill pediculi.

Cimicifugæ Rhizoma. — Cimicifuga. Actæa Racemosæ Radix. The dried rhizome and roots of Cimicifuga racemosa, Black Snake-root.

Characters.—Rhizome from 2 to 6 inches long, ½ to 1 inch thick; hard, nearly cylindrical, bearing the remains of ascending branches. Roots brittle, usually broken off near the rhizome. Colour brownish-black. Odour faint; taste bitter and acrid.

Composition.—Cimicifuga contains a *volatile oil*, two *resins*, and *tannic acid*. The active principle is uncertain. *Dose*, 20 to 30 gr.

Preparations.

1. **Extractum Cimicifugæ Liquidum.**—Alcoholic; 1 in 1. *Dose*, 5 to 30 min.

2. **Tinctura Cimicifugæ.**—1 in 10 of Alcohol 60 per cent.; by percolation. *Dose*, 30 to 60 min.

ACTIONS AND USES.

In moderate doses Black Snake-root is **bitter**; in larger doses it acts much like Digitalis, increasing also the activity of the skin and generative organs.

Cimicifuga has been used as a **stomachic** in diseases of the heart; and in neuralgia, rheumatism, chorea, bronchitis, uterine disorders and spermatorrhœa.

Hydrastis Rhizoma. — HYDRASTIS RHIZOME. The dried rhizome and roots of Hydrastis canadensis.

Characters.—Rhizome tortuous, simple or branched; $\frac{1}{2}$ to $1\frac{1}{2}$ inch long, and $\frac{1}{8}$ to $\frac{1}{2}$ inch thick, with short ascending branches, terminating with scars above, and thin brittle roots below. Externally yellowish-brown; fracture resinous; odour slight, characteristic; taste bitter.

Composition.—Hydrastis contains an alkaloid *hydrastine*, $C_{11}H_{11}NO_2$, *berberine*, and a yellowish *resin*, xanthopuccine.

Preparations.

1. **Extractum Hydrastis Liquidum.**— Alcoholic; 1 in 1. *Dose*, 5 to 15 min.

2. **Tinctura Hydrastis.**—1 in 10 of Alcohol 60 per cent. *Dose*, 30 to 60 min.

ACTIONS AND USES.

Hydrastis, Golden Seal, is a **bitter** and a spinal stimulant causing convulsions, much like Nux Vomica. It is used as a **stomachic and nervine stimulant**; and locally in various kinds of ulceration and hæmorrhage in connection with the nose, rectum and uterus.

BERBERIDACEÆ.

Podophylli Rhizoma.—PODOPHYLLUM RHIZOME Podophyllum Root. The dried rhizome and roots of Podophyllum peltatum, American May-Apple.

Characters.—Dark reddish-brown, smooth or wrinkled. In pieces, several inches long, and from about $\frac{1}{5}$ to $\frac{1}{3}$ of an inch thick, nearly cylindrical, presenting at intervals irregular tuberosities which are marked above by a depressed circular scar, and give off below a number of very brittle brownish

roots, or present a corresponding number of whitish scars. Fracture short; internally whitish and starch-like, or pale yellowish-brown and horny. Odour characteristic; taste slightly bitter and acrid.

Composition.—Podophyllum contains the official *resin*, which yields *podophyllotoxin*, a resinous body, composed of *picropodophyllic acid*, inert, and *picropodophyllin*, a crystalline neutral body, the active principle.

From Podophylli Rhizoma is obtained:

Podophylli Resina.—Podophyllum Resin.

Source.—Made by percolating with Alcohol 90 per cent.; precipitating the resulting tincture in Water acidulated with Hydrochloric Acid; washing, and drying.

Characters.—A pale yellow to deep orange-brown amorphous powder; soluble in alcohol 90 per cent. and in ammonia, partly soluble in ether. Precipitated from alcoholic solution by water; from the ammoniacal by acids. *Dose*, $\frac{1}{4}$ to 1 gr.

Preparation.

Tinctura Podophylli.—1 in 30 of Alcohol 90 per cent.; by maceration. *Dose*, 5 to 15 min.

ACTIONS AND USES.

Externally, Podophyllum Resin possesses no local action; but if applied to a wound, it enters the blood, and exerts its specific effect as a purgative, to be presently described.

Internally, Podophyllum Resin gives rise to a bitter acrid taste; possibly salivation, irritation of the stomach, nausea and colic; and after ten or twelve hours produces a free watery motion. The **purgative** effect appears to be due to stimulation both of the muscular coat and the glands of the intestine, as well as to **increase of the biliary flow.**

Podophyllum Resin is used entirely as a purgative. One-grain doses are given to produce free evacuation of the bowels in severe constipation or portal congestion. A dose of $\frac{1}{6}$ to $\frac{1}{4}$ grain may be employed as an ingredient of habitual laxative pills. It is a useful **cholagogue** when mercurials are contra-indicated. Podophyllum Resin must not be given alone on account of its griping tendency, but combined with a carminative, such as Hyoscyamus, Belladonna, or Cannabis Indica. The comparative slowness of its action must also be remembered.

MAGNOLIACEÆ.

Anisi Stellati Fructus.—Fruit of the Star-Anise. The dried fruit of Illicium verum. From China.

Characters.—Eight carpels diverging horizontally in a stellate manner from an axis; each carpel boat-shaped, beaked, irregularly wrinkled, rusty brown, with a solitary reddish brown seed. Odour and taste like those of Anise.

From Anisi Stellati Fructus is made:

Oleum Anisi. *See* page 305.

ACTIONS AND USES.

These are described at page 305.

MENISPERMACEÆ.

Calumbæ Radix.—CALUMBA ROOT. The dried transversely cut slices of the root of Jateorhiza Columba.

Characters.—Flattish, circular or oval slices, depressed centrally, about 1 to 2 inches broad; from $\frac{1}{8}$ to $\frac{1}{2}$ inch thick; yellowish. Cork brownish, wrinkled; the cortex thick, with radiating lines, a fine dark line separating the two parts. Odour feeble; taste bitter; fracture short.

Composition.—Calumba contains a bitter neutral principle, *calumbin*, $C_{24}H_{17}O_7$, crystallising in white needles; a bitter alkaloid, *berberine*, $C_{20}H_{17}NO_4$, in yellow prisms, whence the colour of the root; a bitter acid, *calumbic acid*, $C_{21}H_{21}O_7$; 33 per cent. of *starch;* but no tannic acid.

Preparations.

1. **Infusum Calumbæ.**—1 in 20 of *cold* Water. *Dose*, $\frac{1}{2}$ to 1 fl.oz.

2. **Liquor Calumbæ Concentratus.**—Aqueous and Alcoholic. 1 in 2. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

3. **Tinctura Calumbæ.**—1 in 10 of alcohol 60 per cent.; by maceration. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

ACTIONS AND USES.

Calumba is the first of the large and important group of bitter substances or **bitters** which we meet with in the

materia medica, and will therefore be fully discussed as the type of this class of remedies. Under the head of the other bitters, such as Quassia and Gentian, fresh description of their actions and uses will be unnecessary, and reference will simply be made to the present account. So with the actions and uses, *as bitters*, of the alkaloids (Strychnine, Quinine, etc.), and of the *aromatic bitters*, including Orange, Lemon, Cascarilla, etc.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Calumba and other bitters are antiseptic and disinfectant to a degree, arresting decomposition and fermentation. They are not used for this purpose.

Internally.—Taken into the mouth, bitters, as their name implies, stimulate the nerves of taste, and therewith induce several reflex effects of the first importance in digestion. (1) The *saliva* is increased, and thus its solvent and digestive influence on the food in the mouth, as well as its stimulant action on the gastric secretion. (2) The *vessels and glands of the stomach* are excited through the central nervous system, and the gastric secretion is thus increased in a second way, an effect which is heightened if the bitter be aromatic and relish given by the pleasant flavour.

Reaching the stomach, Calumba and other bitters stimulate digestion in a third way by acting directly on the gastric nerves and causing a sensation closely resembling hunger. This rouses the appetite; and if food be taken within a few minutes, the other effects just described afford the means of digesting it. As in the mouth, the action of bitters in the stomach is greatly assisted by aromatics (essential oils) and alcohol (contained in tinctures). Like these substances, bitters also stimulate the local circulation, and produce a remote effect on the heart and systemic vessels, raising the blood pressure, and thus acting as "general tonics." They will also exert a certain controlling effect on any decomposition or fermentation which may be set up in the stomach. When given in excess, or for a long time, bitters will manifestly, in every way, tend to irritate the stomach and induce indigestion.

Calumba and bitters in general pass slowly along the *intestines*, moderating decomposition, and slightly stimulating peristalsis unless they contain tannic acid, which many of them do. They are not cholagogue.

The *uses* of Calumba and other bitters internally depend on the actions just described. They are of great value as

stomachics, and are much employed in rousing gastric digestion in atonic dyspepsia, where the appetite and the ability to digest have been diminished or lost, as in anæmia, convalescence from acute diseases, in persons exhausted by overwork, whether mental or bodily, and in the subjects of chronic constitutional diseases, such as phthisis and syphilis. In such cases, bitter infusions form the best vehicle for acid or alkaline stomachics, as the case may require, combined with an aromatic tincture which renders the mixture much more agreeable and active. Their use must not be continued too long without intermission; they must not be given in too concentrated a form; and they must be employed with caution, or entirely avoided, in cases of dyspepsia attended with much pain, vomiting, or mucous secretion, as well as in structural disease of the stomach. Calumba is one of the least irritant of all bitter stomachics.

The action of bitters on the bowels no doubt adds to their value in indigestion, as they remove flatulence and promote evacuation. Some forms of diarrhœa are relieved by Calumba. Whether given by the mouth or as an enema, bitter infusions are **anthelmintic**, preventing and destroying the threadworm.

2. Actions in the Blood, Specific Actions, and Remote Local Actions.

Whether bitters possess any *direct* actions on the blood or tissues beyond those just described, is uncertain. Their *indirect* effect on the system is manifestly great, and of the first importance therapeutically, as they are the means of introducing into the blood an increased amount of nutrient material. In this way bitters are **tonics**, invigorating the body whilst they increase appetite; a system of treatment which is agreeable and striking to invalids and persons enfeebled by disease, over-work, or dyspepsia.

Pareiræ Radix.—Pareira Root. The dried root of Chondrodendron tomentosum.

Characters.—Long cylindrical twisted pieces, ¾ to 2 or more inches thick; with a thin blackish-brown bark, marked with longitudinal furrows and transverse ridges and fissures. Internally yellowish- or brownish-grey, with circles of porous

wood, separated into wedge-shaped portions by large medullary rays, waxy when cut. No odour; taste bitter.

Composition.—Pareira Root contains a bitter alkaloid *pelosine*, $C_{18}H_{21}NO_3$, possibly identical with beberine; *starch*, and *resin*. *Incompatibles.*—Ferric salts, salts of lead, and tincture of iodine.

Preparation.

Extractum Pareiræ Liquidum.—Aqueous and alcoholic. *Dose*, ½ to 2 fl.dr.

ACTIONS AND USES.

The physiological actions of Pareira are imperfectly known, but it is believed to possess mild **bitter** and **laxative** effects, and to be a moderately active **diuretic**.

Empirically, it is used in inflammatory affections of the urinary tract, from the pelvis of the ureter downwards, being held to relieve pain, reduce irritation, and promote healing and cessation of muco-purulent discharge.

Picrotoxinum.—PICROTOXIN. $C_6H_{10}O_4$. A neutral principle obtained from the fruits of Anamirta paniculata (*Cocculus indicus*).

Characters.—Colourless, inodorous, prismatic crystals. Taste bitter. *Solubility.*—1 in 330 of cold, or 35 of boiling, water; 1 in 3 of boiling, 1 in 13 of cold, alcohol 90 per cent.

Dose, $\frac{1}{100}$ to $\frac{1}{25}$ gr.

ACTIONS AND USES.

Externally, Cocculus or Picrotoxin, in the form of an ointment, very carefully applied to the unbroken surface, **destroys pediculi**. *Internally*, Picrotoxin is a very powerful agent which especially stimulates the various centres in the medulla, large doses causing disturbances of respiration and circulation and violent **spasms of the flexors**. It has been chiefly used in the **night-sweating of phthisis**, and in chronic diseases of the nervous system.

PAPAVERACEÆ.

Papaveris Capsulæ.—POPPY CAPSULES. The *nearly ripe* dried fruits of Papaver somniferum, the White Poppy.

Characters.—Rounded, depressed or ovoid capsules, with a thin, dry, brittle pericarp. Usually 2 to 3 inches in diameter, crowned by stellately arranged stigmas. Pericarp yellowish-brown; frequently with blackish spots. Presents internally thin parietal placentas, and very many small reniform reticulated whitish seeds. Fruits inodorous; pericarp bitter.

Composition.—Poppy Capsules contain a little *opium* and woody fibre; the seeds contain a bland oil. See *Opium.*

ACTIONS AND USES.

The actions of Poppy Capsules are the same as those of Opium, but very much weaker. A warm decoction is a favourite **anodyne** fomentation. Preparations of Opium are in every respect preferable.

Opium.—OPIUM. The juice obtained by incision from the *unripe* capsules of Papaver somniferum, the White Poppy, inspissated by spontaneous evaporation.

Characters.—Rounded, irregular, or flattened masses, weighing from 8 ounces to 2 pounds. When fresh, plastic, moist, coarsely granular, and reddish- or chestnut-brown; but becoming harder on keeping, and darkening to blackish-brown. Odour strong, characteristic; taste bitter.

Varieties.—Any suitable variety of Opium may be employed as a source of Tincture of Opium and Extract of Opium of the respective official alkaloidal strengths, provided that when dry it contains not less than 7·5 per cent. of anhydrous morphine; but when otherwise used for official purposes, Opium must be of such a strength that when dried and powdered, the powder heated to 212° F. until it ceases to lose moisture, and the product tested by the official method, such dried powder shall yield not less than 9·5 per cent. and not more than 10·5 per cent. of anhydrous Morphine. *Smyrna, Turkey* or *Levant* Opium is the best. It occurs in irregular, rounded or flattened masses, seldom more than two pounds in weight, enveloped in poppy leaves, and surrounded with the fruits or seeds of rumex. Good Smyrna Opium yields 10 to 12 per cent. of Morphine. *Constantinople* Opium is generally inferior to Smyrna. It is found in cakes, either large and irregular, or small and lenticular, covered with a poppy leaf, and marked with its midrib, but without rumex seeds. It smells much less strongly than Smyrna Opium. *Egyptian*

Opium occurs in round flattened cakes of a reddish hue, with vestiges of a leaf. *Persian* Opium is in sticks or lumps. *Indian* Opium is in balls enveloped in poppy leaves, or in cakes. There are also *French* and *English* varieties.

Composition.—Opium contains (1) certain *alkaloids;* (2) a *neutral substance;* (3) two organic *acids;* (4) about 16 per cent. of *water;* (5) resin, gum, salts, extractives, odorous principles, and other constituents of plants. The *most* important of these are as follows:

	Parts in 100 parts.	Constitution.	Reaction.	Characters.
1. Morphine	5 to 12	$C_{17}H_{19}NO_3 + H_2O$	Alkaline	White needles.
2. Codeine	up to ·6	$C_{18}H_{21}NO_3$	Alkaline	*See* page 228.
3. Thebaine or Paramorphine	up to ·3	$C_{19}H_{21}NO_3$	Alkaline	White plates, with acrid styptic taste.
4. Opianine ...	·5 to 1	—	—	—
5. Cryptopine ...		$C_{23}H_{25}NO_5$	Alkaline	—
6. Metamorphine		—	—	—
7. Papaverine		$C_{20}H_{21}NO_4$	Alkaline	White needles.
8. Narcotine	4 to 6	$C_{22}H_{23}NO_7$	Alkaline	Shining prisms; tasteless, odourless.
9. Narceine	up to ·02	$C_{23}H_{29}NO_9$	Alkaline	Fine white needles; odourless, bitter.
10. Porphyroxin ...	—	—	—	—
11. Laudanine... ...	—	$C_{20}H_{25}NO_4$	Alkaline	—
12. Meconin	·08 to ·3	$C_{10}H_{10}O_4$	Neutral	White needles; odourless, acrid.
13. Meconic Acid ...	4 to 8	$C_7H_4O_7$	Acid	—
14. Thebolactic Acid	—	Probably Lactic Acid	Acid	—

Impurities (chiefly adulterations).—Opium is often soft from excess of water, which causes a great variation in the strength. Stones, fruits, leaves, etc., may be detected by filtering a decoction; and starch by the iodine test. *Test.*—The official test is intended to ascertain the amount of Morphine in specimens which are pure but of doubtful richness. It consists in (1) triturating 14 grammes of Opium, dried at 212° F. and powdered, with 6 grammes of Calcium Hydroxide and 40 cc. of Water, adding more water, stirring, and filtering; (2) adding to the filtrate 10 cc. of Alcohol 90 per cent., and 50 cc. of Ether, and shaking; (3) adding

4 grammes of Ammonium Chloride, shaking frequently, separating the Morphine by standing, collecting it on a filter, washing, drying and weighing; and (4) titrating ·5 gramme of the crystals with decinormal volumetric solution of H_2SO_4. The result should correspond to about 10 per cent. of anhydrous Morphine.

General chemical characters, reactions and incompatibilities of Opium.—A fluid (watery or alcoholic) preparation of Opium reddens litmus paper (free meconic acid). It gives a deep red colour with ferric chloride (meconic acid), precipitates with lead acetate and subacetate, silver nitrate, zinc, copper, and arsenic (meconates, sulphates, and colouring matter); a precipitate with tincture of galls or astringent preparations (codeine tannate). It becomes turbid with fixed alkalis and their carbonates, alkaline earths, and ammonia (precipitated morphine and narcotine).

Dose of Opium.—$\frac{1}{2}$ to 2 gr.

Preparations.

1. **Emplastrum Opii.**—1 in 10, with Resin Plaster.

2. **Extractum Opii.**—Aqueous. Contains 2 of Opium in 1, or 20 per cent. of Morphine. *Dose*, $\frac{1}{4}$ to 1 gr.

From Extractum Opii is prepared:

Extractum Opii Liquidum.—·75 of Extract macerated in 16 of Water, with 4 of Alcohol 90 per cent. added. Contains $\frac{3}{4}$ grain of Morphine in 110 minims. *Dose*, 5 to 30 min.

3. **Pilula Plumbi cum Opio.**—Opium, 1; Lead Acetate, 6; Syrup of Glucose, ·7. 1 in 8. *Dose*, 2 to 4 gr.

4. **Pilula Saponis Composita.**—Opium, 1; Hard Soap, 3; Syrup of Glucose, 1. 1 in 5. *Dose*, 2 to 4 gr.

5. **Pulvis Opii Compositus.**—Opium, 3; Black Pepper, 4; Ginger, 10; Caraway Fruit, 12; Tragacanth, 1. 1 in 10. *Dose*, 2 to 10 gr.

6. **Pulvis Ipecacuanhæ Compositus.**—Dover's Powder. Opium, 1; Ipecacuanha, 1; Potassium Sulphate, 8. 1 in 10. *Dose*, 5 to 15 gr.

From Dover's Powder is prepared:

Pilula Ipecacuanhæ cum Scilla.—Compound Powder of Ipecacuanha, 3; Squill, 1; Ammoniacum, 1; Syrup of Glucose, *q.s.* 1 of Opium in 20. *Dose*, 4 to 8 gr.

7. **Pulvis Kino Compositus.**—Opium, 1; Kino, 15; Cinnamon, 4. 1 in 20. *Dose*, 5 to 20 gr.

8. **Pulvis Cretæ Aromaticus cum Opio.**—Opium, 1; Aromatic Powder of Chalk, 39. 1 in 40. *Dose*, 10 to 40 gr.

9. **Suppositoria Plumbi Composita.**—Opium, 1 gr.; Lead Acetate, 3 gr.; and Oil of Theobroma, 11 gr. 1 gr. of Opium in each Suppository.

10. **Tinctura Opii.** — Laudanum. Opium, 1·5; Alcohol 90 per cent. and Distilled Water, of each a sufficiency to produce a standardised tincture containing 1 gr. of Opium in 15 min. or ·75–·80 gramme of anhydrous Morphine in 100 cc. *Dose*, 5 to 15 min. repeated; 20 to 30 min. at once.

From Tinctura Opii are prepared:

a. LINIMENTUM OPII.—Equal parts of Tincture of Opium and Liniment of Soap. 1 in 27.

b. TINCTURA OPII AMMONIATA.—"Scotch Paregoric." Tincture of Opium, 150; Benzoic Acid, 20·6; Oil of Anise, 6·25; Solution of Ammonia, 200; Alcohol 90 per cent., to make 1000. Contains ·62 gr. of Opium in 1 fl.dr. (1 in 88), or 5 gr. in 1 fl.oz. *Dose*, 30 to 60 min.

c. TINCTURA CAMPHORÆ COMPOSITA.—Paregoric; Paregoric Elixir. Tincture of Opium, 60·9; Benzoic Acid, 4·6; Camphor, 3·4; Oil of Anise, 3·1; Alcohol 60 per cent., to make 1000. Contains ·25 gr. of Opium, or $\frac{1}{30}$ gr. Morphine Hydrochloride, in 1 fl.dr. *Dose*, 30 to 60 min.

11. **Unguentum Gallæ cum Opio.**—Opium, 15; Gall Ointment, 185. 7·5 in 100.

From Opium are made:

12. **Morphinæ Hydrochloridum.**— Morphine Hydrochloride. $C_{17}H_{19}NO_3,HCl,3H_2O$. The Hydrochloride of an alkaloid obtained from Opium.

Characters.—White acicular prisms of silky lustre, or a white powder consisting of minute cubical crystals. *Solubility.*—1 in 24 of cold, 1 in 1 of boiling, water; 1 in 50 of alcohol. Solutions yield a white precipitate with KHO, soluble in excess. Morphine salts give an orange-red colour when moistened with HNO_3; a greenish-blue with neutral

solution of Fe_2Cl_6. *Incompatibles.*—The alkaline carbonates; lime water; salts of lead, iron, copper, mercury, and zinc; Liquor Arsenicalis, and all astringent vegetable preparations. *Impurities.*—Other alkaloids, mineral matters. *Dose*, $\frac{1}{8}$ to $\frac{1}{2}$ gr.

Preparations.

a. **Liquor Morphinæ Hydrochloridi.**—Solution of Morphine Hydrochloride. 1 of Morphine Hydrochloride in 100 of a mixture of Alcohol 90 per cent., Water and Diluted Hydrochloric Acid. 1 gr. in 110 min. *Dose*, 10 to 60 min.

b. **Suppositoria Morphinæ.**—$\frac{1}{4}$ gr. in each, with $14\frac{3}{4}$ gr. of Oil of Theobroma.

c. **Tinctura Chloroformi et Morphinæ Composita.**—$\frac{1}{11}$ gr. of Morphine Hydrochloride in 10 min. *See* page 167.

d. **Trochiscus Morphinæ.**—$\frac{1}{36}$ gr. of Morphine Hydrochloride, with Tolu Basis.

e. **Trochiscus Morphinæ et Ipecacuanhæ.**—$\frac{1}{36}$ gr. of Morphine Hydrochloride, and $\frac{1}{12}$ gr. of Ipecacuanha, with Tolu Basis.

13. **Morphinæ Acetas.**—Morphine Acetate, $C_{17}H_{19}NO_3,C_2H_4O_2,3H_2O$, carefully dried.

Source.—Made by neutralising Morphine with Acetic Acid.

Characters.—A white crystalline or amorphous powder. *Solubility.*—1 in $2\frac{1}{2}$ of water; 1 in 100 of Alcohol 90 per cent. *Dose*, $\frac{1}{8}$ to $\frac{1}{2}$ gr.

Preparation.

Liquor Morphinæ Acetatis.—Solution of Morphine Acetate. 1 of Morphine Acetate in 100 of a mixture of Alcohol 90 per cent., Distilled Water and Diluted Acetic Acid. 1 gr. in 110 min. *Dose*, 10 to 60 min.

14. **Morphinæ Tartras.**—Morphine Tartrate. $(C_{17}H_{19}NO_3)_2C_4H_6O_6,3H_2O$.

Source.—Prepared by the combination in molecular proportions of Morphine and Tartaric Acid.

Characters.—A white powder, consisting of fine nodular tufts of minute acicular crystals, efflorescent. *Solubility.*—1 in 11 of cold water; almost insoluble in alcohol 90 per cent. *Dose*, $\frac{1}{8}$ to $\frac{1}{2}$ gr.

Preparations.

a. **Injectio Morphinæ Hypodermica.** Hypodermic Injection of Morphine. Made by dissolving 5 of Morphine Tartrate in 100 of Distilled Water recently boiled and cooled. 1 gr. of Tartrate in 22 min. *Dose*, hypodermically, 2 to 5 min.

b, **Liquor Morphinæ Tartratis.**—1 of Morphine Tartrate in 100 of a mixture of Alcohol 90 per cent. and Distilled Water. 1 gr. in 110 min. *Dose*, 10 to 60 min.

15. **Codeina.**—Codeine. $C_{17}H_{18}(CH_3)NO_3, H_2O$. An alkaloid obtained from Opium or Morphine.

Characters.—Nearly colourless trimetric crystals. *Solubility.*—1 in 80 of water or of Solution of Ammonia; readily in alcohol 90 per cent., in chloroform, and in diluted acids; 1 in 30 of ether. Aqueous solution is alkaline and bitter. *Impurities.*—Morphine and others. *Dose*, $\frac{1}{4}$ to 2 gr.

16. **Codeinæ Phosphas.**—Codeine Phosphate. The phosphate $(C_{17}H_{18}(CH_3)NO_3, H_3PO_4)_2, 3H_2O$ of an alkaloid obtained from Opium or from Morphine.

Characters.—White crystals, bitter. *Solubility.*—1 in 4 of water; less soluble in alcohol 90 per cent. *Dose*, $\frac{1}{4}$ to 2 gr.

Preparation.

Syrupus Codeinæ.—$\frac{1}{4}$ gr. Codeine Phosphate in 1 fl. dr. of Syrup and Water. *Dose*, $\frac{1}{2}$ to 2 fl. dr.

17. **Diacetyl-Morphine Hydrochloride.**—"Heroin." (*Not official*). A white crystalline powder, soluble in water. *Dose*, $\frac{1}{20}$ to $\frac{1}{12}$ gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Opium is generally believed to be anæsthetic and anodyne when applied to the unbroken skin; and the Emplastrum, Linimentum, fomentations made from the Tincture, and other preparations are used to relieve the pains of neuralgia, lumbago, abscess, etc. It is doubtful, however, whether Morphine can be absorbed by the unbroken skin; and the benefit derived from these applications may be due to the spirit, or to the heat. Wounds, ulcers, and exposed

mucous surfaces readily absorb Morphine or Opium, which are used in painful ulcers, conjunctivitis and similar diseases. Morphine is occasionally given by the *endermic* method, especially in the epigastric region. *Hypodermic injection* is a most valuable means of administration, when a rapid or local effect is specially desired, or when the stomach is irritable or inaccessible.

Internally.—Opium is quickly absorbed by the mucous membrane of the *mouth*, and exerts an action there which, although in part also specific and in part remote, is chiefly an immediate local one. A full medicinal dose renders the mouth dry and the tongue foul, from **diminution of the secretions,** with thickness of the voice and some thirst. On entering the *stomach* Opium may cause sickness, from brief irritation of the nerves, but sensibility is quickly reduced; hunger and pain are relieved or removed; appetite, gastric secretion, and digestive activity diminished; and the afferent impressions which give rise to vomiting arrested, so that direct emetics will no longer act. Anorexia, nausea, and sickness may occur as *sequelæ* of the same or of larger doses.

These effects of Opium on the stomach have a double bearing in therapeutics. First, they indicate that it has a constant tendency to **derange digestion.** Secondly, it is a powerful means of relieving gastric pain and vomiting, whatever their cause, but especially in the acute catarrh which remains as the effect of irritant food, alcohol, or poison, after these have been removed; in ulcer, "chronic," or malignant; and in reflex sickness, due to disease, irritation, or operation, in some other part of the abdomen. In chronic dyspeptic pain it is manifestly contra-indicated.

The action of Opium on the *intestine* is distinctly sedative, although very brief primary stimulation may sometimes be recognised. Both the sensible and insensible impressions from the mucous membrane are diminished or arrested by medicinal doses; pain is prevented or relieved; and the secretions become less abundant. At the same time peristalsis is rendered more feeble or is completely arrested by stimulation of the splanchnics, the inhibitory nerves of the intestinal walls. The total result on the bowel is **anodyne and astringent.** Opium is therefore a most valuable remedy for unnatural frequency of the bowels, as in simple diarrhœa, the first stage of cholera, the ulceration of typhoid fever and tuberculosis, and irritant poisoning. In all such cases, however, it must be employed with the cautions to be afterwards insisted on; and in most instances it is best prescribed as an addition to other astringents, such as Chalk, Lead, and

Tannic Acid in its many forms; the amount of Opium being a minimum, but still sufficient to assist the less powerful drugs. It has the further advantage of relieving abdominal pain. Even infants (see *Cautions*, page 238) may thus be treated for diarrhœa with the greatest benefit. Very large doses of Opium paralyse the splanchnics in animals, increasing peristalsis; and diarrhœa may be observed in man under similar conditions.

Opium relieves pain and collapse in hernia, intestinal obstruction, peritonitis, and visceral perforations, ruptures and wounds; but must be given with this end only until surgical measures can be employed, for it produces dangerous **paralysis of the bowel** and masks guiding symptoms.

Given by the rectum, as an enema or the Suppository, Opium relieves local pain, diarrhœa, and spasm of the rectum or neighbouring parts; sets the pelvic organs at rest after operation; and prevents irritation of the rectum by nutrient enemata. The dose of Opium by the rectum should be half as much again as by the mouth.

A trace of Morphine is excreted unabsorbed in the fæces.

2. ACTION ON THE BLOOD.

Morphine enters the circulation less quickly than some other alkaloids, although the first traces of the drug are rapidly discovered in the blood. Thus its full action is comparatively slowly developed, and solid Opium continues to exert local effects even in the colon, portion by portion of the Morphine being absorbed into the vessels. The red corpuscles are said to be reduced in size indirectly, possibly through slowing of the circulation and want of oxygen.

3. SPECIFIC ACTIONS.

After administration Morphine can be found in the body not as such, but in the form of oxymorphine, $C_9\ H_{36}N_2O_6$. All the organs, probably without exception, are physiologically affected by it; but its principal action is exerted upon the nervous system.

The *convolutions* are first briefly excited, and afterwards depressed, apparently by direct action of the Morphine upon the nerve cells, not on the cerebral vessels. The stage of Opium excitement is said to transcend even the first stage of alcoholic intoxication in the exaltation of feelings, the sense of happiness and comfort, the brilliancy of imagination, and the increase of intellectual power and mental vigour generally, all accompanied by brightness of expression and manner. But the effect of Opium, even in this stage, is

rarely one of pure exaltation, and in most persons is perhaps never so. There is generally some perversion of the faculties, and the imagination becomes extravagant, wandering into the land of dreams, of the grotesque, and the impossible. Depression now supervenes: the various perceptive and sensory centres in the convolutions are more or less depressed, according to the dose; impressions made upon the afferent nerves, including pain, do not readily affect the centres; the subject becomes drowsy, and finally sleeps; and if he momentarily respond to a sharp inquiry or other forms of stimulation, he quickly relapses into heavy sopor. When the dose is excessive, the stage of excitement is entirely absent, the cerebrum is speedily and profoundly depressed, and no response follows severe forms of stimulation, such as flagellation: the patient is comatose. These effects of Opium on the brain as a **stimulant, anodyne, hypnotic and narcotic** are more marked in man and in highly intellectual races than in animals and lower races, respectively. In cold-blooded animals they are quite subordinate to the effects of stimulation of the cord.

The *ganglia at the base of the brain* are affected by Opium, whence **contraction of the pupil** and disturbed accommodation.

The *motor centres in the brain and spinal cord* are at first briefly stimulated by Opium, reflex excitability being increased, as shown by restlessness in man and convulsions in animals. At the stage of cerebral depression, languor and muscular weakness, of central origin, set in, and the subject lies down; but there is not then complete loss of muscular power and irritability, and even in dangerous poisoning the patient can be marched about if supported on either side.

Following close upon the convolutions and cord, the great vital centres in the *medulla* are markedly affected by Opium. *Vomiting* is not uncommon as one of the first effects. The *respiratory* centre, at first unaffected, is then depressed, the respiratory movements becoming quiet, superficial, and irregular; and death by Opium poisoning is due to **paralysis of the respiratory centre** and arrest of breathing, that is, to asphyxia. The *cardiac* centre is more resistant to Morphine: it is first excited so as to increase inhibition (after evanescent acceleration); but it is soon depressed, and the pulse rises in frequency. The *vascular* centre is depressed, but never to a dangerous extent; and even in complete narcosis, when respiration is failing, the blood-pressure (pulse) responds to afferent stimuli. The full action of Opium on the respiration, heart and vessels will be immediately described.

We shall presently find that the therapeutical value of the action of Opium on the central nervous system lies in the fact that it depresses the perceptive and sensory centres so much earlier and more profoundly than the vital centres in the medulla. Its effects on the pupil, heart, vessels, respiration and cord are of less positive value in treatment, and in some respects unfortunate.

The functions of the *sensory nerve terminations* are lowered or arrested by Opium, common sensibility being especially reduced, so that pain cannot be originated; but this peripheral anæsthetic or anodyne effect of Morphine given by the mouth is decidedly secondary, both in time and in degree, to its allied action on the sentient centres, and to its local effect when administered by hypodermic injection, already described.

The conductivity of the *sensory nerve trunks* is diminished by local injection of Morphine, as well as by its internal administration; this offering a second interruption to the flow of painful impressions inwards.

The *motor nerves* are first briefly excited, and then paralysed from the centres outwards. *Muscular* irritability is never completely lost.

The action of Opium upon the centres of several of the *viscera* has been partly described under the previous heads. In addition, it **depresses the afferent (including the sensory) nerves of all organs,** and acts upon many of the viscera directly. The *heart* is temporarily accelerated by Opium, in part through the cardiac centre, in part through its intrinsic ganglia. Thereafter, or with fuller doses, it is slowed by stimulation of the vagus in the medulla and heart. Finally, the **cardiac vagus is depressed** or paralysed; but by this time the intrinsic ganglia are so depressed that acceleration is impossible, and the action remains infrequent whilst very feeble. Very rarely death occurs by sudden cardiac failure.

The *vessels*, dilated through the centre, as described, are not *directly* influenced by Opium, either in their muscular coats or in their peripheral nerves.

Whilst the *respiratory* movements of the chest are impaired through the centre, so that they become feeble and tend to cease, the afferent nerves of breathing, that is, the branches of the vagus arising in the lungs and passages, are also depressed. Thus reflexion is dulled or arrested at its very origin, and dyspnœal excitement (hyperpnœa), cough, spasm, and other reflex respiratory acts are rendered more difficult or are altogether prevented. At the same time the bronchial secretions are diminished or inspissated by the

action of the drug upon the glands, and the activity of the pulmonary circulation is lowered with the general blood-pressure and by the weakening of the respiratory movements. **The total effect of Opium upon the respiratory functions is thus powerfully depressant.**

The biliary and glycogenic functions of the *liver* are affected by Morphine, which may cause pale stools or even jaundice, and markedly diminish the amount of sugar in diabetes mellitus. **Hepatic and general metabolism is reduced in activity,** the amount of urea and probably of carbonic acid excreted being distinctly diminished. The *temperature* rises for a time, and then falls, apparently varying with the blood-pressure.

4. SPECIFIC USES.

The hypnotic and anodyne effects of Opium constitute it by far the most valuable drug of its kind, and the most important article of the whole *materia medica.* It is constantly employed to induce sleep, relieve pain, and calm excitement; this combination of properties making Opium greatly superior to Chloral Hydrate and other simple hypnotics, on the one hand, and to Aconite, Belladonna, Quinine, and other direct or indirect anodynes, on the other hand. Speaking broadly, it is used in sleeplessness due to pain; in the insomnia of exhaustion, overwork, fever or insanity, and in the restlessness and anxiety of visceral disease, the quantity, combinations, and time of administration being carefully arranged. In delirium Chloral Hydrate is often preferred, especially in delirium tremens; but Opium is more suitable in the delirium of mania, and in the later stages of fevers, when the temperature is falling and the respiration and circulation are not oppressed. It has been recommended in heat pyrexia, combined with Quinine.

There are but few kinds of *pain* that cannot be relieved by Opium; whether it be wise to administer it in every instance is another question. The unbearable distress attending the passage of renal and biliary calculi; the pains of neuralgia, acute rheumatism and malignant disease, and of fractures, dislocations and other injuries, are a few examples of conditions in which Opium is essential. In all cases where pain is urgent the hypodermic method should be chosen. In gout it is to be used only when the pain is excessive, as it tends to aggravate the cause. In hysterical pain recourse to it is undesirable. Other local visceral pains will be noticed presently. The pain and shock of operations are treated with a full dose of Opium.

No use is made of the action of Opium on the iris and ciliary nerves.

As an antispasmodic, Opium is less employed, for various reasons, *e.g.* in epilepsy and other convulsive diseases; but it relieves some cases of spasmodic asthma, whooping-cough and spasmodic stricture of the urethra.

The violent spasms and pains of certain diseases of the *cord* may yield to no other form of treatment than Morphine hypodermically.

From its action on the medulla, Opium has been recommended as an antidote to Belladonna, which is so far its physiological antagonist, as we shall see (page 239); but it must be used with caution, and only in the stage of excitement.

The practical points connected with the vital centres will now be noticed under the heart, vessels and respiration.

In diseases of the *heart*, Opium is of great value to relieve pain, anxiety and distress, whilst, as we have seen, it is a cardiac depressant. Towards the end of most cases of cardiac disease, the greatest discrimination is called for as to whether Opium may or may not be given. The safe rule is to trust to other anodynes, such as direct and indirect stimulants, and measures for relieving the circulation; but it is equally true that in some cases of heart disease unspeakable relief and permanent benefit may be obtained by the hypodermic injection of Morphine. This subject must be studied in books on the practice of medicine.

From its soothing effect upon the *vessels* and circulation generally, Opium is a **hæmostatic** of the first order, but requires to be used with judgment. In hæmoptysis it is given in moderate doses, to promote rest and sleep, to relieve cough, to depress the circulation slightly by slowing and weakening the heart and dilating the vessels, and to relieve the mind of the anxiety which aggravates the bleeding. In intestinal hæmorrhage it is of great value, arresting, as it also does, the movements of the bowel. It is best given with Lead or preparations containing Tannic Acid.

The soothing influence of Opium on the bronchi, lungs, the afferent nerves and the centre of *respiration*, accounts for its extensive employment in cough, pain, dyspnœa and other distressing symptoms in the chest. Its power here is unquestionable; but for this very reason the danger attending it is great. Cough and dyspnœa are frequently beneficial acts, and are not to be arrested in a routine fashion by sedatives, but, if possible, by the removal of their cause. When cough is due to some irremovable condition, such as a

growth in the lungs or bronchi, to pressure, to remote (reflex) irritation, or to excessive irritability of the nerves and centre, Opium is indicated and may be given with benefit. On the other hand, in cough and respiratory distress with abundant secretion, as in the bronchitis of the old and infirm or of the very young and feeble, Opium leads to retention and inspissation of the products, aggravation of the cause, and asphyxia, and is on no account to be given. Between these extremes lies every variety of case in which Opium may suggest itself, *e.g.* in phthisis and recurrent bronchial catarrh. The rules of practice here should be not to prescribe Opium unless other means have failed, such as the many expectorants, and attention to food, warmth, etc.; and that, when given, Opium must be ordered in small doses combined with expectorants, such as Ammonia and Ipecacuanha, which will prevent dangerous depression of the local nerves and centres. In acute inflammation of the pleura, or pleuro-pneumonia, it may be necessary to relieve severe pain in the chest, harassing cough, sleeplessness and mental distress by Morphine hypodermically. Opium must be ordered with the greatest hesitation for asthma, as the Opium habit is readily acquired in this disease. Its employment in hæmoptysis has been already noticed.

With respect to the *liver and metabolism*, Opium is by far the most powerful drug known for reducing or removing sugar from the urine in diabetes mellitus, and therewith ameliorating the condition of the patient in most respects. Very large doses of solid Opium, Codeine or Morphine may be tolerated in this disease, their effect on the nervous system being remarkably absent whilst the diabetes mellitus is yielding. Acute inflammatory and febrile diseases are now less frequently treated with Opium than formerly, when a combination with Calomel was in general use, the Opium preventing the purgative action of the mercurial, and the latter preventing constipation, whilst both drugs were believed to act specifically on the morbid process, reducing the local and general circulation, alleviating pain and restlessness, and promoting healing. The combination Opium and Mercury is, moreover, very valuable in syphilis. In the specific fevers, such as typhoid, Opium given with judgment relieves delirium, as we have seen, checks diarrhœa, and is invaluable in hæmorrhage, perforation or peritonitis. Phagedæna and some kinds of ulceration may call for its free exhibition.

Opium is employed in obstetrics to prevent abortion, in some varieties of difficult labour, and to relieve after-pains

5. Remote Local Actions and Uses.

The excretion of Morphine commences quickly, but may not be completed for forty-eight hours. It leaves the body by most of the secretions, especially the bile. In the urine it is found mainly unchanged. **The quantity of urine may be diminished;** its evacuation disturbed from the local action of Morphine on the nervo-muscular mechanism of the bladder; part of the Morphine reabsorbed; and sugar present. These facts, and the probability of the retention and accumulation of Morphine in the system if the action of the kidneys be deficient, indicate the necessity to give it only with the greatest caution, in reduced doses or not at all, according to circumstances, in renal disorder or disease.

Morphine in passing though the *skin* may cause itching, heat, and sometimes eruptions. The vessels are also dilated, as we have seen, and the sweat glands decidedly stimulated; both being effects of its central, not of its local cutaneous action. Thus Opium, especially in the form of Dover's Powder, is a valuable **diaphoretic,** and is given with great success as a refrigerant antipyretic, in the onset of catarrh, influenza, and mild febrile or rheumatic attacks caused by cold. In certain circumstances Dover's Powder checks the sweating of phthisis, probably by removing its cause. Being excreted in the milk, Morphine must be prescribed with great caution to nursing females.

6. Actions and Uses of the Principal Constituents of Opium.

1. **Morphine.—The action of opium depends chiefly on morphine,** and the description just given applies so nearly to the pure alkaloid, that only a few points of difference require to be noticed. These depend upon two principal circumstances: (1) Opium, being much less soluble than the pharmacopœial preparations of Morphine, is more slowly absorbed, and thus acts less quickly than Morphine, whilst its effects are more lasting, and its immediate local action on the intestines is decidedly more marked. (2) Several of the constituents of Opium possess more or less convulsant actions (Thebaine, Codeine, Narcotine), Morphine none (in man); the latter has therefore a more sedative influence than the entire drug. The effect of Morphine on the skin is also less marked than that of Opium. Unless there be some special reason to the contrary, Morphine is generally to be preferred to Opium in practice, as being of definite composition (whilst the crude drug is very variable), more rapid in action, and readily

administered hypodermically, whilst the dyspeptic and constipating effects of the drug are less marked. Opium is to be preferred in intestinal and abdominal diseases, such as diarrhœa, obstruction, peritonitis and hernia, because it reaches the bowel directly; in delirium tremens and mental disorder, because its action is more continued; in diabetes, because it is very much safer; for combinations with Quinine or Calomel, and as a diaphoretic, because it prevents purgation and lowers fever; in astringent enemata, from its action on the bowel; and for local applications, *e.g.* to the conjunctiva, because less irritant than the alkaloid. The relative strength of Opium to Morphine is about $\frac{1}{5}$ or $\frac{1}{3}$ to 1.

2. **Codeine.**—This alkaloid appears to **excite the cord** more than Morphine and to depress the convolutions less, so that muscular tremors may follow and exceed its sedative influence. Codeine, in $\frac{1}{2}$-gr. doses cautiously increased, until 20 gr. or more may be taken *per diem*, markedly **reduces the amount of sugar** in diabetes. It is also employed to prevent or relieve pain in connection with the abdominal nerves; and, as the Syrup, to allay troublesome cough.

3. *Narcotine*, which is so large a constituent of Opium, is probably often impure from an admixture of Morphine. By some authorities it is considered to be **hypnotic,** by others convulsant. It is not used.

4. *Narceine* probably **acts like morphine,** and is not employed medicinally.

5. *Thebaine* is a **convulsant,** almost like Strychnine.

6. Opianine, Cryptopine, Metamorphine, and possibly Papaverine, **act like Morphine.** Porphyroxin and Laudanine **act like Codeine.**

7. The action of *Meconic Acid* is doubtful.

7. Applications of the various preparations of Opium.

This subject will be best discussed from the point of view of the conditions calling for Opium.

1. *Severe pain*, such as colic or neuralgia, is to be treated with the Hypodermic Injection of Morphine. Failing this, either of the Solutions of Morphine must be given by the mouth, or a fluid preparation of Opium, such as the Tincture, or the Liquid Extract. An enema made with the Tincture and mucilage of starch is a valuable anodyne in cases of abdominal pain. The Pilula Saponis Composita also acts rapidly, being more readily soluble in the stomach than solid Opium.

2. *Superficial pain* may be met with local applications, such

as the Plaster, Liniment, or fomentations made with Laudanum or other fluid preparation; but, as we saw, the value of the drug itself in these applications is very doubtful.

3. *As a hypnotic*, the best forms are the Tincture, the Liquid Extract, the Solutions of Morphine, and the Soap and Opium Pill; the particular preparation and the dose being regulated by the degree of sleeplessness and by the pain which may accompany it. Dover's Powder is an excellent hypnotic in the restlessness at the commencement of feverish attacks.

4. As a *sedative to the stomach*, various preparations may be tried, such as the Solutions of Morphine in effervescing mixtures, Morphine endermically or hypodermically over the epigastrium; sometimes solid Opium or the Extract in the form of a small pill, or Dover's Powder combined with Bismuth Oxycarbonate, or Sodium Bicarbonate.

5. As a *sedative and astringent to the bowels*, Laudanum, either by the mouth or in an enema, may be given in urgent cases attended by much pain. When there is less urgency we may prescribe one of the powders: Compound Powder of Opium, Chalk and Opium, Kino and Opium, or Dover's Powder. Morphine Acetate with Lead Acetate and Acetic Acid, or the Lead and Opium Pill may be demanded in severe diarrhœa, especially if hæmorrhage threaten. Solid Opium, alone or combined with Calomel, is the best form in hernia, peritonitis and intestinal obstruction.

6. As *sedatives to the rectum*, bladder, pelvic organs, and urethra, we order one of the Suppositories of Opium or Morphine, or an enema.

7. *Cough* may be relieved by several special preparations, namely: Tinctura Camphoræ Composita, Tinctura Opii Ammoniata, the Trochiscus Morphinæ, Trochiscus Morphinæ et Ipecacuanhæ, Pilula Ipecacuanhæ cum Scilla, Syrupus Codeinæ, and Heroin.

8. *Diaphoresis* may be accomplished with Dover's Powder.

The uses of the other preparations are obvious.

Influences modifying the actions and uses of Opium. Dangers: Cautions.—*Age* greatly modifies the effects of Opium, children being particularly susceptible of its influence on the convolutions and medulla. An infant of one year should not be given more than half a minim of the Tincture for an ordinary dose, and nursing mothers should be ordered Opium with special precautions. *Females* are more easily affected than males. Certain individuals have peculiar *idiosyncrasies* as regards Opium, some resisting its action, others being excited by it, others again very readily nar-

cotised; whilst some persons suffer from a species of shock after the hypodermic injection of Morphine, becoming sick, faint, or even alarmingly collapsed. The effect of *habit* is extremely marked in Opium, the necessary dose steadily rising until large quantities are taken. This can be safely done for a time, but presently the habit becomes uncontrollable, and a disorder known as Opium-eating, Morphinism or Morphino-mania is established. *Disease*, especially *pain*, affords great resistant power to the action of Opium, which appears to expend itself on the morbid process. The quality of the Opium, the particular preparation and the combinations used also modify its action. On the contrary, Opium and Morphine act more powerfully in the subjects of renal disease, as we have already seen. Morphine and Opium are *contra-indicated* because dangerous, or they are to be used with special care in diseases of the respiratory organs, the heart, and the kidneys; in congestive conditions and hyperæmia of the brain; and in alcoholic intoxication.

Opium and Belladonna: Combinations and Antagonism of Morphine and Atropine.—In several respects the actions of Morphine are opposed to those of Atropine, the active principle of Belladonna. The *antagonism* between the two substances is in part real, such as their respective effects on the convolutions, respiratory centre and intestines. In part it is apparent only. Thus, the contraction of the pupil caused by Morphine occurs through the pupillary centre; the dilatation caused by Atropine is referable to paralysis of the ciliary branches of the third nerve. Morphine is diaphoretic through the centres; Atropine is anhidrotic through the terminal nerves of the glands. Both depress the heart and reduce the blood-pressure in poisonous doses. Thus Morphine and Atropine are not true antagonists, but the one may prevent or relieve certain effects of the other, and may therefore be (1) combined with the other for particular medicinal purposes, or (2) given in the treatment of poisoning by the other under particular circumstances.

(1) *Combinations* of Morphine and Atropine are now used for hypodermic injection ($\frac{1}{100}$, $\frac{1}{50}$, or even $\frac{1}{10}$ gr. of Sulphate of Atropine, to each grain of Acetate of Morphine) to prevent certain unpleasant effects of the latter. It is found that the immediate sickness and depression, and the subsequent dyspepsia and constipation, may thus be avoided, and a more natural sleep induced. The combination is preferable when Morphine is given as a hypnotic or anodyne; in conditions of cardiac depression and disease of the lungs; in obstruction of the bowels; and to relieve spasms. The

Atropine should be avoided in cerebral excitement, especially mania.

(2) *Use as mutual antidotes.*—Sulphate of Atropine, in doses of $\frac{1}{10}$ gr. may be injected subcutaneously every quarter of an hour in Opium poisoning, the pulse and respiration being carefully watched. Three or four doses may thus be given; but the ordinary means of resuscitation, especially artificial respiration, must not be interrupted for a moment. In poisoning by Belladonna, Morphine should be given subcutaneously, with the same precautions, in doses of $\frac{1}{4}$ gr.

Apomorphinæ Hydrochloridum. — APOMORPHINE HYDROCHLORIDE. $C_{17}H_{17}NO_2,HCl$. The hydrochloride of an alkaloid obtained by heating Morphine Hydrochloride or Codeine Hydrochloride in sealed tubes with Hydrochloric Acid. $C_{17}H_{19}NO_3 = C_{17}H_{17}NO_2 + H_2O$, the alkaloid losing one molecule of water.

Characters.—Small, greyish-white, shining needles, turning green on exposure to light and air, inodorous, very faintly acid. *Solubility.*—1 in 50 of water; more soluble in alcohol 90 per cent. Solutions become decomposed and green when boiled; give with $NaHCO_3$ a precipitate which becomes green on standing, and then forms a purple solution with ether violet with chloroform, and bluish-green with alcohol 90 per cent. With dilute test solution of ferric chloride it gives a deep red, with nitric acid a blood-red, coloration. The salt should be rejected if it imparts an emerald-green colour to 100 parts of water, *Dose*, $\frac{1}{20}$ to $\frac{1}{10}$ gr. hypodermically; $\frac{1}{10}$ to $\frac{1}{4}$ gr. by the mouth.

Preparation.

Injectio Apomorphinæ Hypodermica.—1 dissolved in 1 of Diluted Hydrochloric Acid and 100 of Distilled Water recently boiled and cooled. To be prepared as required. 1 gr. in 110 min. *Dose*, subcutaneously, 5 to 10 min.

ACTIONS AND USES.

Apomorphine is the most certain of all emetics, acting upon the vomiting centre and but little on the stomach, *i.e.* being mainly an indirect emetic. In 5 to 20 minutes it causes moderate nausea, repeated vomiting, and the disturbances of the respiratory and circulatory organs produced by

emetics. (*See* p. 489.) If the dose have been sufficient, the evacuation of the stomach is certain and complete. Larger doses cause prostration and paralysis of the voluntary muscles, depression of the respiratory centre, acceleration of the heart, and fall of temperature. Apomorphine may be used for the many purposes of emetics in general. Its special advantages consist in its certainty; the absence of local irritation of the stomach; the readiness with which it can be given hypodermically, that is to patients unable to swallow, as a small non-irritant injection; and the slightness of the after-effects. Small doses ($\frac{1}{20}$ gr.) are **expectorant**, and 5 min. of the Injection given by the mouth may be used in bronchitis.

Rhœados Petala. — Red-Poppy Petals. The fresh petals of Papaver Rhœas. Indigenous.

Characters.—Scarlet; outline transversely elliptical, 2 inches broad, surface smooth lustrous, margin entire, odour characteristic; taste bitter.

Composition.—Red Poppies contain 40 per cent. of red colouring matter, readily soluble in water, consisting of *papaveric* and *rhœadic acids*; an alkaloid *rhœadine*, $C_{21}H_{21}NO_6$, without narcotic properties; but no Morphine.

Preparation.

Syrupus Rhœados.—Made with Water, by infusion; Sugar; and Alcohol 90 per cent. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

USE.

Syrup of Red Poppies is used as a **colouring agent only.**

CRUCIFERÆ.

Sinapis Albæ Semina.—White Mustard Seed. The dried ripe seeds of Brassica alba.

Characters.—About $\frac{1}{12}$ of an inch in diameter, $\frac{1}{10}$ gr. in weight, spheroidal, pale yellow; with very finely pitted, reticulated testa; externally hard; internally yellow, oily. Inodorous; taste less pungent than of black mustard seeds.

Sinapis Nigræ Semina.—Black Mustard Seed. The dried ripe seeds of Brassica nigra.

Characters.—Scarcely half the size of White Mustard seeds, $\frac{1}{50}$ gr. in weight, spherical or ovoidal, dark-reddish- or greyish-brown, testa finely pitted, hard; internally yellowish-green and oily. Inodorous when dry, and even when powdered, but when rubbed with water yielding a strong pungent odour and irritating the eyes; taste bitter at first, then very pungent.

Substances resembling Black Mustard: Colchicum Seeds, which are larger, lighter, and not quite spherical.

Composition.—The seeds of *Sinapis nigra* contain: (1) about 35 per cent. of a bland *fixed oil*. When this has been expressed, and the powdered mustard mixed with water at 120° and distilled, there is obtained (2) the official *volatile oil*, *Oleum Sinapis Volatile*, C_3H_5CNS, allyl sulphocyanate, described below. As the seeds and powder of the mustard are devoid of these irritant properties, the oil cannot exist ready-formed in them, but is developed by a decomposition of their constituents. On the addition of water to the Black Mustard, its most important principle, *potassium myronate*, or *sinigrin*, $KC_{10}H_{18}NS_2O_{10}$ (a compound of potassium with an acid glucoside, *myronic acid*), is broken up by another constituent, *myrosin*, an enzyme, into volatile oil of mustard, potassium sulphate and sugar, thus: $KC_{10}H_{18}NS_2O_{10} = C_3H_5CNS + KHSO_4 + C_6H_{12}O_6$. *Sinapis alba* also contains (1) the fixed oil. It does not, however, yield the volatile oil, but (2) a substance with allied properties, called *acrinyl sulphocyanate*, C_7H_7CNSO, by a similar decomposition of its constituents, *sinalbin*, $C_{30}H_{44}N_2S_2O_{16}$ (in place of potassium myronate) and myrosin; thus: $C_{30}H_{44}N_2S_2O_{16} = C_7H_7CNSO + C_{16}H_{23}CNO_5,H_2SO_4$ (sinapin disulphate) $+ C_6H_{12}O_6$ (glucose).

From Sinapis Nigræ Semina is made:

Oleum Sinapis Volatile.—Volatile Oil of Mustard. *Source.*—Distilled from Black Mustard Seed after maceration with water.

Characters.—Colourless or pale yellow, with intensely penetrating odour and very acrid taste. Almost immediately vesicates the skin. *Solubility.*—Readily in alcohol and ether. Boils at 297°–306° F. Sp. gr. 1·018 to 1·030. *Impurities.*—Ethylic alcohol and petroleum.

Preparation.

Linimentum Sinapis.—*Volatile* Oil, 2; Camphor, 3; Castor Oil, 7; and Alcohol 90 per cent. 43, 1 in 27.

Sinapis.—MUSTARD. The dried ripe seeds of Brassica nigra and Brassica alba, Black and White Mustard, powdered and mixed.

Characters.—A greenish-yellow powder, of bitter pungent taste, inodorous when dry, but yielding when moist a pungent penetrating odour; very irritating to nostrils and eyes. *Impurities.*—Starch and turmeric.

Preparation.

Charta Sinapis.—Mustard Paper. Bruised Black and White Mustard Seeds percolated with benzol to extract the *fixed* oil; the residue dried, powdered, mixed with Solution of Indiarubber, and spread on cartridge paper, which is then dried.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—When applied to a limited area of skin, Mustard acts quickly (1) as a **rubefacient** and nervous **stimulant**, causing redness, heat and severe burning pain. (2) This effect is followed by **loss of sensibility** of the part to other impressions, and relief of previously existing pain. (3) Prolonged application of the Charta or of a mustard poultice causes **vesication**, by producing local inflammation. Neighbouring and deeper parts, and viscera in vascular communication or intimate nervous relation with the blistered area, may thus have their circulation relieved (*see* p. 608). The heart, blood-pressure, respiration, and nervous centres generally are stimulated by the first application of Mustard to the skin; soothed during the stage of anæsthesia and relief of pain; and depressed in the third stage, especially if the vesication be too severe through neglect. Applied to the whole or a large part of the surface of the skin in the form of a bath, Mustard dilates the cutaneous vessels, and thus relieves the blood-pressure in the viscera.

In the form of a poultice or of the Liniment or Paper, Mustard is extensively used as a readily available, convenient and rapid means of relieving local pain, stimulating the internal organs, and producing **counter-irritation**, with evanescent and mild after-effects. It is applied to relieve the pains of muscular rheumatism (lumbago, etc.), neuralgia in any part of the body, the indefinite pains in the chest in chronic disease of the lungs or heart, and colic, gastralgia

and other forms of distress in the abdomen. As a cardio-vascular and respiratory stimulant, a large sinapism may be applied to the calves or soles in syncope, coma, or asphyxia, whether from disease or from poisoning. The counter-irritant effect of Mustard is chiefly used in inflammation of the throat, larynx, bronchi, lungs, pleura and pericardium; sometimes in abdominal diseases; frequently, and with success, in morbid conditions of the stomach and persistent vomiting from any cause. Diffused through a warm bath it is a popular "derivative" in cerebral congestions, in headache, and at the onset of colds and febrile diseases in children. A Mustard sitz bath may stimulate menstruation if taken at the period.

Internally.—Mustard produces a pungent impression on the tongue and olfactory organs, a sense of warmth in the stomach, with increase of relish and appetite and of the circulation in the gastric wall. It is therefore the most familiar of condiments. In full doses it is **emetic**, with rapid stimulation and but little subsequent depression. From one to four teaspoonfuls may be given, stirred up with a tumblerful of warm water in cases where other emetics are not available or have failed, especially in poisoning by narcotics.

2. ACTION IN THE BLOOD, SPECIFIC, AND REMOTE LOCAL ACTIONS.

The odour of Oil of Mustard can be detected in the blood. Its specific action is obscure, and never taken advantage of medicinally. Oil of Mustard is partly excreted by the lungs.

Armoraciæ Radix.— HORSERADISH ROOT. The fresh root of Cochlearia Armoracia. Cultivated in Britain.

Characters.—A nearly cylindrical root, ½ to 1 inch in diameter, a foot or more in length; pale yellowish- or brownish-white externally, whitish within; taste very pungent; odour pungent when bruised or scraped. *Substance resembling Horseradish*: Aconite Root, which is short, conical, darker, and causes tingling when chewed.

Composition.—Horseradish yields, along with other constituents, a *volatile oil*, C_4H_9CNS (butyl sulphocyanate), closely allied to the volatile oil of black mustard, and formed, like it, by decomposition of a more complex principle by the agency of a ferment.

Preparation.

Spiritus Armoraciæ Compositus.—1 in 8, by distillation with dried Bitter-Orange Peel, Nutmeg, Alcohol 90 per cent., and Water. *Dose*, 1 to 2 fl.dr.

ACTIONS AND USES.

Horseradish has been used in domestic medicine as a counter-irritant, but is most familiar as a pleasant condiment, possessing much the same properties as Mustard. The Compound Spirit is a **flavouring and carminative agent.**

POLYGALACEÆ.

Senegæ Radix.—Senega Root. The dried root of Polygala Senega.

Characters.—Greyish- or brownish-yellow slender roots varying from 2 to 4 inches in length, enlarged at the top into a knotty crown which bears the bases of numerous slender aërial stems. Roots curved or contorted, sparingly branched, keeled, longitudinally wrinkled, with transverse cracks in the cortex, and short fracture. Odour distinctive; taste at first somewhat sweet, afterwards acrid. *Substances resembling Senega* : Arnica, Valerian, Serpentary. All these have no keel.

Composition.—The active principle of Senega is *saponin*, a colourless amorphous glucoside, $C_{32}H_{54}O_{13}$, yielding a frothy solution with water, and decomposed by HCl into a sugar and *sapogenin* ($C_{14}H_{22}O_2$). Saponin is closely allied to *digitonin*, one of the active principles of Digitalis.

Preparations.

1. **Infusum Senegæ.**—1 in 20 of boiling Water. *Dose*, ½ to 1 fl.oz.

2. **Liquor Senegæ Concentratus.**—Alcoholic. 1 in 2. *Dose*, ½ to 1 fl.dr.

3. **Tinctura Senegæ.**—1 in 5 of Alcohol 60 per cent.; by percolation. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Applied to the mucous membrane of the nose or throat, in the form of powder (snuff), Senega is a powerful irritant, causing reflex hyperæmia, sneezing, cough and

mucous flow. These effects of the drug are not employed therapeutically, but are a key to its remote local action. Solutions of Saponin injected under the skin are violent local irritants and general depressants; the heart, vessels, central and peripheral nervous system and muscles being all affected.

Internally.—The action of Senega on the stomach and intestines is moderately irritant, large doses causing epigastric heat, sickness and diarrhœa; and medicinal doses **deranging digestion.** The absence of severe general symptoms indicates the difficulty of its absorption by the stomach.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS, AND REMOTE LOCAL ACTIONS AND USES.

Saponin passes through the blood to the tissues, diminishes the frequency of the heart, and probably affects the circulation much like Digitalis, but in a manner which is more uncertain. *See* page 365.

It appears to be excreted in part by the bronchial mucosa, which it stimulates remotely as it does when locally applied. The circulatory, muscular, and nutritive activity of the tubes is increased; the mucous secretion is rendered more abundant and watery; and the afferent nerves are stimulated, so that reflex cough is the result. The total action is said to be **expectorant,** the bronchial contents being expelled in greater volume and with greater force, *i.e.* more readily and easily. Senega is in common use as a stimulant expectorant, being given in the second stage of acute bronchitis, in chronic bronchitis, and in bronchiectasis, to liquefy and evacuate the contents of the tubes or cavities, and stimulate the "weak" surface of the mucous membrane. It is contra-indicated in the first stage of acute bronchitis, in phthisis, and when digestion is feeble or deranged. Saponin is probably excreted in part by the skin and kidneys, both of which it stimulates, increasing the volume of the urine and its most important solid constituents.

Krameriæ Radix.—KRAMERIA ROOT. RHATANY ROOT. The dried root of (1) Para Rhatany, a species of Krameria attributed to Krameria argentea; or of (2) Peruvian Rhatany, Krameria triandra.

Characters.—1. Para Rhatany is in cylindrical pieces, purplish brown, with smooth, thicker, adherent bark, marked by deep transverse cracks. Fracture short. 2. Peruvian

Rhatany consists of (*a*) a readily separable bark, thinner than that of Para; rough and scaly except in the smaller pieces, dark reddish-brown externally, bright brownish-red within; and (*b*) a yellowish woody axis. Fracture splintery. The bark of both kinds has a strongly astringent taste, and tinges the saliva red; odour not marked.

Composition.—Krameria Root contains from 20 to 45 per cent. of *rhatania-tannic acid*, $C_{54}H_{24}O_{21}$, a red amorphous substance, the watery solutions of which first colour ferric chloride green and then precipitate it, but are not precipitated by tartar emetic. *Incompatibles.*—Alkalis, lime water, salts of iron and lead, and gelatin.

Preparations.

1. **Extractum Krameriæ.**—Aqueous. *Dose*, 5 to 15 gr.

From Extractum Krameriæ are prepared:

(*a*) Trochiscus Krameriæ.—1 gr. of Extract with Fruit Basis.

(*b*) Trochiscus Krameriæ et Cocainæ.—1 gr. of Extract and $\frac{1}{20}$ gr. of Cocaine Hydrochloride, with Fruit Basis.

2. **Infusum Krameriæ.**—1 in 20 of boiling Water. *Dose*, $\frac{1}{2}$ to 1 fl.oz.

3. **Liquor Krameriæ Concentratus.** — Alcoholic. 1 in 2. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

4. **Tinctura Krameriæ.**—1 in 5 of Alcohol 60 per cent.; by percolation. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

Krameria is also contained in Pulvis Catechu Compositus, 1 in 5. *See* page 321.

ACTIONS AND USES.

The preparations of Rhatany possess the **properties of Tannic Acid**, and may be employed for the same purposes (see *Acidum Tannicum*, page 394), except that they are obviously of no use in poisoning by antimony.

SAPINDACEÆ.

Guarana.—(*Not official.*) The seeds of Paullinia sorbilis, reduced to powder after roasting, and made into a stiff paste with water. Brazilian Cocoa.

Characters.—Cylindrical rolls of dried paste.

Composition.—Guarana contains no less than five per cent. of *caffeine*, $C_8H_{10}N_4O_2,H_2O$, the alkaloid of the coffee and tea plants; united, as in these, with *tannic acid*, *starch* and *gum* (*see* page 322). *Dose*, 15 to 60 gr. in powder, or as infusion.

ACTIONS AND USES.

The action of Guarana closely resembles that of strong tea or coffee. It is chiefly used in megrim. See *Caffeina*, page 322.

LINACEÆ

Cocæ Folia.—COCA LEAVES. The dried leaves of Erythroxylum Coca and its varieties.

Characters.—The leaves imported from Bolivia vary from 1½ to 3 inches in length, and from 1 to 1½ inch in breadth; brownish-green, oval, entire and glabrous; upper surface bearing a distinct ridge above the midrib. On under surface near midrib, and on either side of it, a curved line is usually visible. Midrib prolonged into a minute horny apiculus, frequently broken off. Odour faint but characteristic; taste slightly bitter, succeeded by a sensation of numbness. The leaves imported from Peru are somewhat smaller, narrower, more fragile; pale green, without a prominent ridge above the midrib on upper surface, and with less distinct curved lines on each side of it on under surface.

Composition.—Coca Leaves contain about 0·2 per cent. of an alkaloid, *cocaine;* a second alkaloid, *ecgonine*, $C_9H_{15}NO_3$; *hygrin*, an aromatic substance; *coca-tannin*, and *coca-wax*. Cocaine is official. It yields ecgonine, benzoic acid and methyl-alcohol when heated with strong HCl.

Preparation.

1. **Extractum Cocæ Liquidum.**—1 in 1, with Alcohol 60 per cent. *Dose*, ½ to 1 fl. dr.

From Coca Leaves are made:

2. **Cocaina.**—COCAINE. An alkaloid, $C_{17}H_{21}NO_4$, obtained from the leaves of Erythroxylum Coca and its varieties.

Characters.—Colourless monoclinic prisms; taste bitter, followed by a sensation of tingling and numbness.

Melts at 204·8° to 208·4°. *Solubility.*—Almost insoluble in water; insoluble in glycerin; 1 in 10 of alcohol 90 per cent.; 1 in 4 of ether; 2 in 1 of chloroform; 1 in 12 of olive oil; 1 in 14 of oil of turpentine. *Impurities.*—Chlorides, sulphates.

Preparation.

Unguentum Cocainæ.—1; Oleic Acid, 4; Lard, 20.

3. **Cocainæ Hydrochloridum.**—Cocaine Hydrochloride. $C_{17}H_{21}NO_4,HCl$. The hydrochloride of an alkaloid obtained from the leaves of Erythroxylum Coca and its varieties.

Characters.—Colourless needles or a crystalline powder. Melts at 356° to 366·8° F. *Solubility.*—2 in 1 of cold water, 1 in 4 of alcohol 90 per cent., or of glycerin; almost insoluble in ether; insoluble in olive oil. Its solution in water is neutral and colourless; has a bitter taste; and produces on the tongue tingling, followed by numbness. It gives a yellow precipitate with auric chloride. *Impurities.*—Cinnamyl cocaine and cocamine and other derivatives of cocaine.

Dose, $\frac{1}{6}$ to $\frac{1}{2}$ gr.

Preparations.

1. Injectio Cocainæ Hypodermica.—Hypodermic Injection of Cocaine. 10 of Cocaine Hydrochloride in about 100 of a mixture of Salicylic Acid and Distilled Water recently boiled and cooled. About 1 gr. in 11 min. *Dose, by subcutaneous injection*, 2 to 5 min.

2. Lamellæ Cocainæ.—Discs of Cocaine. Discs of Gelatin, with some Glycerin, each weighing about $\frac{1}{30}$ gr., and containing $\frac{1}{50}$ gr. of Cocaine Hydrochloride.

Cocaine Hydrochloride is also contained in Trochiscus Krameriæ et Cocainæ, $\frac{1}{20}$ gr. in each.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

A solution of Hydrochloride of Cocaine has a powerful local action when administered hypodermically, or applied to

an exposed mucous surface such as the tongue or conjunctiva, rapidly paralysing the sensory nerves and contracting the vessels. It thus **produces local anæsthesia and anæmia,** which last for fifteen minutes or more, according to the strength of solution used, and may be followed by temporary dilatation of the vessels. The Hypodermic Injection is used as a local anæsthetic, to prevent or remove the pain attending minor operations on the surface of the body, and is of special value in the surgery of the eye, nose, ear, throat, teeth, rectum, vagina and urethra. In the form of spray it must always be employed with care, particularly to the nose or throat. A 4 per cent. solution is commonly used, being applied once or twice before operation at intervals of a few minutes. Examinations of the eye and throat are also greatly facilitated by the previous application of Cocaine. In painful or nervous affections of the same or other parts, such as neuralgia (hypodermically with caution), burns, itching, whooping cough, tuberculous laryngitis, dental caries, and hay fever, it is also of use, strong applications being avoided as likely to increase the subsequent congestion of the parts. Its local application to the conjunctiva is followed in six or eight minutes by temporary dilatation of the pupil and impairment of accommodation, effects apparently due to irritation of the sympathetic.

2. SPECIFIC ACTIONS AND USES.

Coca is **stimulant, tonic and restorative** when given internally, enabling persons who chew the leaf to undergo great muscular exertion with little or no fatigue. In animals it causes great muscular restlessness or excitement, and finally convulsions of cerebral origin; the whole brain, medulla, and cord being powerfully stimulated from above downwards. Very large doses paralyse the posterior columns of the cord and the peripheral sensory nerves, but do not affect the motor tract. The muscles remain unaffected. The pupils are dilated by internal as well as by local administration. Respiration rises in frequency, is disturbed in rhythm, and finally ceases. The heart is greatly accelerated, by vagus paralysis; the blood-pressure rises and then falls, perhaps dangerously. The amount of urea is said to be diminished, as if from diminished metabolism; but Coca does not prolong the life of starved animals. The temperature may be raised.

This drug has been used to prevent muscular exhaustion; in some forms of nervous and muscular debility, and in wasting attended by increased formation of urea; in convalescence; in mental exhaustion; and in the alcoholic and opium habits. On the other hand, the employment of this drug sometimes

develops the cocaine habit or chronic cocainism, comparable with morphinism in its unfortunate characters and results.

Eucaine-α, a benzoyl-methyl compound of oxypiperidine, and **Eucaine-β**, the hydrochloride of benzoyl-vinyl-diacetonalkamine, are two synthetic compounds chemically and pharmacologically allied to cocaine. They are used like it, but their action is slower and less toxic, and their solutions can be sterilised by boiling without being decomposed.

Linum.—Linseed. The dried ripe seeds of Linum usitatissimum, Flax.

Characters.—Small, brown, flat, ovate, pointed, with acute edges; $\frac{1}{6}$ to $\frac{1}{4}$ of an inch long; smooth, glossy externally, yellowish-white within; inodorous, with a mucilaginous oily taste.

Composition.—The seeds of Flax contain *mucilage*, and the official *fixed oil*, which consists chiefly of glyceryl united with *linoleic acid*. Crushed linseed, after expression of the oil, contains mucilage, proteids, salts and a little oil.

From Linum are made:

1. **Linum Contusum.**—Crushed Linseed. Linseed reduced to a coarse powder; recently prepared. *Impurities.*—Starch and mineral matters.

2. **Oleum Lini.**—Made by expression at ordinary temperatures. Viscid, yellow, with faint odour and bland taste.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Crushed Linseed is used only as a poultice, which is intended to **convey heat and moisture** to parts, and thus affect the nerves, circulation and nutrition generally. The Oil may be applied to burns, either pure or mixed with an equal quantity of Lime water—constituting Carron Oil, a substitute for Linimentum Calcis.

Internally.—An infusion of Linseed, "Linseed Tea," is a familiar **demulcent** drink.

2. ACTIONS IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTIONS.

Linseed Tea is supposed to have a specific or remote local effect as a demulcent on the bronchi and urinary passages, but this is probably referable to the warm water only. It may be **slightly diuretic**, for Oil of Linseed becomes oxydised in the system (as it does on exposure to air), and is excreted by the kidneys as a resinoid body which stimulates these organs.

MALVACEÆ.

Gossypium.—COTTON. COTTON WOOL. The hairs of the seed of Gossypium barbadense, and of other species of Gossypium, freed from fatty matter.

Characters.—Long white soft filaments, each consisting of an elongated cell, under the microscope appearing as a flattened twisted band with slightly thickened rounded edges; inodorous; tasteless. Readily wetted by water, without yielding either an alkaline or an acid reaction.

From Gossypium is made:

Pyroxylinum.—Pyroxylin. "Gun Cotton." $C_6H_8(NO_2)_2O_5$. Made by immersing Cotton in a mixture of Sulphuric and Nitric Acids, washing free from acid in distilled water, draining and drying. Readily soluble in a mixture of equal volumes of Ether and Alcohol 90 per cent.; leaves no residue when ignited.

Preparations.

1. **Collodium.**—Collodion. Made by dissolving Pyroxylin, 1; in Ether, 36; and Alcohol 90 per cent., 12.

From Collodium is prepared:

COLLODIUM FLEXILE.—Collodion, 48; Canada Turpentine, 2; and Castor Oil, 1.

2. **Collodium Vesicans.**—Blistering Collodion. Pyroxylin, 1; dissolved in Blistering Liquid, 40.

ACTIONS AND USES.

The actions and uses of Cotton Wool are sufficiently familiar.

Pyroxylin is introduced into the Pharmacopœia for the purpose of making Collodion.

Collodion, when painted on the skin or other exposed part, instantly dries by evaporation of the ether, and forms a fine film, which serves as a **protective** to thin, inflamed, broken or incised surfaces. It is used to prevent bed-sores, arrest hæmorrhage (as in leech bites), and close fissures or punctures made with aspirateurs or trocars in paracentesis. *Flexible Collodion* does not contract on drying, nor readily crack, and is a better form for most of the above purposes.

The root-bark of the cotton plant is believed to be ecbolic.

RUTACEÆ.

Aurantii Cortex Siccatus. — Dried Bitter-Orange Peel. The dried outer part of the pericarp of Citrus Aurantium, var. Bigaradia.

Characters.—Thin strips, of a deep orange-red colour externally, nearly free from the white spongy portion of the pericarp; odour aromatic and pleasant; taste, bitter.

Composition.—Orange Peel contains 1 to 2½ per cent. of volatile oil, *oleum corticis aurantii*, isomeric with oil of turpentine, $C_{10}H_{16}$, and a bitter crystalline principle, *hesperidin*.

Preparations.

1. **Infusum Aurantii.**—1 in 20 of boiling Water. *Dose*, ½ to 1 fl.oz.

2. **Infusum Aurantii Compositum.** — 25; with fresh Lemon Peel, 12·5; Cloves, 6·25; boiling Water, to make 1000. *Dose*, ½ to 1 fl.oz.

Aurantii Cortex Recens. — Fresh Bitter-Orange Peel. The fresh outer part of the pericarp of Citrus Aurantium, var. Bigaradia.

Characters.—Deep orange-red or red, rough and glandular externally; only a very small portion of white spongy portion of pericarp internally; odour aromatic, pleasant; taste bitter.

Preparations.

1. **Tinctura Aurantii.**—1 in 4 of Alcohol 90 per cent.; by maceration. *Dose*, ½ to 1 fl.dr.

From Tinctura Aurantii are prepared:

a. Syrupus Aromaticus.—1, with Cinnamon Water, 1; shaken with talc and filtered; Syrup, 2. *Dose*, ½ to 1 fl.dr.

b. Syrupus Aurantii.—1; Syrup, 7. *Dose*, ½ to 1 fl.dr.

Tinctura Aurantii is also an ingredient of Syrupus Cascaræ Aromaticus, Tinctura Quininæ, Confectio Sulphuris, and Trochiscus Sulphuris.

2. **Vinum Aurantii.**—Made by fermentation of a saccharine solution, to which fresh Bitter-Orange Peel has been added. Contains 10 to 12 per cent. by volume of Ethyl Hydroxide.

Vinum Aurantii is used in making Vinum Ferri Citratis and Vinum Quininæ.

Bitter-Orange Peel is also an ingredient of Spiritus Armoraciæ Compositus, Tinctura Cinchonæ Composita, Infusum Gentianæ Compositum, and Tinctura Gentianæ Composita.

Aqua Aurantii Floris.—Orange-Flower Water. Water prepared by distillation from the flowers of the Bitter-Orange tree, Citrus Aurantium, var. Bigaradia. To be diluted with twice its volume of distilled water immediately before use.

Characters.—Colourless or slightly greenish; very fragrant; bitter. *Impurity.*—Lead, derived from the vessels in which it is imported.

Composition.—Orange flowers yield a volatile oil, *oleum Neroli*, and a trace of a bitter principle.

Preparation.

Syrupus Aurantii Floris. — Undiluted Orange Flower Water, 1; Refined Sugar, 6; Water to make 9. *Dose*, ½ to 1 fl.dr.

Undiluted Orange Flower Water is contained in Mistura Olei Ricini and in Syrupus Calcii Lactophosphatis.

ACTIONS AND USES.

Orange is at once an **aromatic and a bitter** substance, and combines the actions of these two classes of remedies, as described under *Caryophyllum* (page 290) and *Calumba* (page 219) respectively. It is extensively used as a highly

agreeable flavouring agent in cookery, pharmacy and the manufacture of liqueurs; and in these several ways may be turned to account therapeutically. It is but feebly bitter.

Limonis Cortex.—Lemon Peel. The fresh outer part of the pericarp of the fruit of Citrus medica, var. β Limonum.

Characters.—Thin pieces, pale yellow and rough on the outer surface from the presence of glands containing volatile oil; having little of the white spongy portion of the rind. Odour strong, characteristic, fragrant; taste warm, aromatic and bitter.

Composition.—Lemon Peel contains the official *volatile oil, Oleum Limonis*, $C_{10}H_{16}$, and a bitter principle, *hesperidin*.

Preparations.

1. **Syrupus Limonis.**—2; Lemon Juice, 50; Refined Sugar, 76; Alcohol 90 per cent., 4. *Dose*, ½ to 1 fl.dr.

2. **Tinctura Limonis.**—1 in 4 of Alcohol 90 per cent.; by maceration. *Dose*, ½ to 1 fl.dr.

From Lemon Peel is made:

Oleum Limonis.—*Source.*—Obtained from fresh Lemon Peel. *Characters.*—Pale yellow; fragrant; warm, bitter, aromatic. Sp. gr. 0·857 to ·860.

Dose, ½ to 3 min.

Lemon Peel is also contained in Infusum Aurantii Compositum and Infusum Gentianæ Compositum; *Oil of Lemon in* Linimentum Potassii Iodidi cum Sapone, Spiritus Ammoniæ Aromaticus, Tinctura Guaiaci Ammoniata, and Tinctura Valerianæ Ammoniata.

ACTIONS AND USES.

The actions and uses of Lemon Peel are the same as those of Orange, the only difference being in the flavour.

Limonis Succus.—Lemon Juice. The freshly expressed juice of the ripe fruit of Citrus medica var. β Limonum.

Characters.—A slightly turbid yellowish liquid, with a grateful odour and sharply acid taste. Sp. gr. 1·030 to 1·040. One fluid ounce contains 30 to 40 gr. of Citric Acid; and half a fluid ounce neutralises: 25 gr. of Potassium Bicarbonate, nearly 21 gr. of Sodium Bicarbonate, or about 13 gr. of Ammonium Carbonate.

Composition.—Lemon Juice contains *citric acid*, $C_3H_4{\cdot}OH{\cdot}(COOH)_3$, H_2O (*see* page 146), both free and combined with *potassium* and other bases; *malic acid*, $H_3C_4H_3O_5$, and *phosphoric acid*, etc.

Preparation.

Syrupus Limonis.—See *Limonis Cortex*, page 255.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Lemon Juice in the mouth and stomach has the same action as Citric Acid, and is used chiefly to **relieve thirst and produce effervescing mixtures and drinks.** *See* page 147.

2. ACTIONS ON THE BLOOD, AND SPECIFIC ACTIONS AND USES.

Lemon Juice enters the blood as alkaline citrates, potassium salts, and phosphoric acid. Here the citrates are in part oxydised into carbonic acid and water (see *Acidum Citricum*, page 148). The potassium and phosphoric acid probably act upon the red corpuscles, of which both are important constituents.

Lemon Juice is used with great success in the prevention and **treatment of scurvy**, a disease the precise nature of which is still obscure, but which is no doubt produced by the want of the juices of fresh vegetable and animal food. The Citric Acid, the Potash, and the Phosphoric Acid have severally been credited with the beneficial effect by different authorities. Lemon Juice has also been given in acute rheumatism and gout, but appears to be useful only in as far as it contains alkalis.

3. REMOTE LOCAL ACTIONS AND USES.

These, which are of great interest, are fully described under Citric Acid.

Buchu Folia.—Buchu Leaves The dried leaves of Barosma betulina.

Characters.—From ½ to ¾ of an inch in length, dull yellowish-green, rhomboid-obovate in outline, rigid, and when slightly moist, cartilaginous. Surface glabrous and somewhat warty; margin usually sharply denticulate, apex blunt and recurved. Oil-glands distinctly visible in the leaf, especially near the margin. Odour and taste strong and characteristic. *Impurity.*—Leaves of *Emplanum serrulatum;* have no glands. *Substances resembling Buchu:* Senna and Uva Ursi, which have entire leaves.

Composition.—Buchu contains a yellowish-brown *volatile oil,* in the glands or "dots," consisting of a crystalline stearoptene dissolved in a liquid hydrocarbon; and a *bitter substance.*

Preparations.

1. **Infusum Buchu.**—1 in 20 of boiling Water. *Dose,* 1 to 2 fl. oz.

2. **Tinctura Buchu.**—1 in 5 of Alcohol 60 per cent.; by percolation. *Dose,* ½ to 1 fl. dr.

ACTIONS AND USES.

The actions and uses of Buchu closely resemble those of Pareira, to the description of which the student is referred. It is more frequently employed than Pareira, its Infusion constituting an excellent vehicle for saline diuretics.

Cuspariæ Cortex.—Cusparia Bark. "Angustura Bark." The dried bark of Cusparia febrifuga.

Characters.—Flattened or curved pieces, or quills 4 or 5 inches long, 1 inch wide, $\frac{1}{12}$ inch thick, *obliquely cut* on inner edge. Coated externally with a yellowish-grey mottled corky layer which can easily be scraped off, exposing a hard dark-brown inner layer: inner surface light brown, laminated. Fracture short and resinous, exhibiting, under a lens, numerous white points or lines. Odour musty; taste bitter. *Impurity.*—The bark of Strychnos Nux vomica ("false angustura bark"); distinguished by its inner surface giving an arterial blood-red colour with HNO_3 (brucine); whilst true Cusparia Bark does not.

Composition.—Cusparia contains a crystalline bitter alkaloid, *cusparine* or *angusturine,* a second bitter substance, an *aromatic oil,* but no tannic acid

Preparations.

1. **Infusum Cuspariæ.**—1 in 20 of boiling Water *Dose*, 1 to 2 fl. oz.

2. **Liquor Cuspariæ Concentratus.**—Alcoholic. 1 in 2. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Cusparia belongs to the group of **aromatic bitters,** the actions and uses of which are fully discussed under *Caryophyllum* (page 290) and *Calumba* (page 219) respectively. Like other bitters, it has been credited with **antipyretic and antiperiodic** properties, and in South America, its native place, is used instead of Cinchona for malarial diseases.

Jaborandi Folia.—JABORANDI LEAVES. The dried leaflets of Pilocarpus Jaborandi.

Characters.—Dull green, oval-oblong or oblong-lanceolate in outline, varying from 2½ to 4 inches in length. Shortly petiolate, obtuse and emarginate at the apex, and mostly unequal at the base; margin entire and slightly revolute; texture coriaceous. Mature leaves are glabrous or exhibit at most a few scattered hairs on the under surface; on the upper surface the lateral veinlets are distinctly prominent. They emit when bruised a slight aromatic odour; taste at first somewhat bitter and aromatic, afterwards pungent. When chewed they increase the flow of saliva. *Impurities.*—Leaves of species of Piper; not oval-oblong,

Composition.—Jaborandi contains *pilocarpine*, $C_{11}H_{16}N_2O_2$, a liquid colourless alkaloid, to which its chief effects are due. It also yields a second (isomeric) alkaloid, *jaborine*, closely resembling atropine in its action, and antagonistic to pilocarpine; as well as *pilocarpidine* and *jaboridine*, acting respectively like pilocarpine and jaborine, and probably oxydation products of these. (*Dose*, 5 to 60 gr.)

Preparations.

1 **Extractum Jaborandi Liquidum.**—Alcoholic 1 in 1. *Dose*, 5 to 15 min.

2 **Tinctura Jaborandi.**—1 in 5 of Alcohol 45 per cent.; by percolation. *Dose*, ½ to 1 fl.dr.

From Jaborandi is made :

Pilocarpinæ Nitras. — Pilocarpine Nitrate. $C_{11}H_{16}N_2O_2$, HNO_3.

Characters. — A white crystalline powder. *Solubility.*—1 in 9 in water; slightly in cold, freely in hot, Alcohol 90 per cent. Strong Sulphuric Acid forms with it a yellowish solution, which, on the addition of Potassium Bichromate, gradually acquires an emerald-green colour. *Dose*, $\frac{1}{20}$ to $\frac{1}{2}$ gr. by the mouth; ($\frac{1}{10}$ to $\frac{1}{3}$ gr. hypodermically).

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Jaborandi applied to the conjunctiva causes **contraction of the pupil** by stimulation of the ends of the third nerve, spasm of the apparatus of accommodation, and disturbance of vision. The effect commences in ten minutes, and lasts from $1\frac{1}{2}$ to 24 hours before finally disappearing. Pilocarpine is used in some cases of inflammation of the eye, such as iritis; in certain forms of blindness; and in paralysis of the muscles.

Internally, in full doses, Jaborandi is liable to cause nausea, vomiting, and increased peristalsis from direct action on the gastric branches of the vagus.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

Pilocarpine enters the blood rapidly, and passes thence into the tissues. The striking effects of Jaborandi consist in **profuse salivation, and perspiration, disturbance of vision, and circulatory depression,** which last for hours, and leave a sense of drowsiness and debility.

Salivation is due to stimulation of the terminal ends of the chorda tympani in the glands, as well as of its centre. The flow commences in about five minutes after a moderate dose, and may last several hours. It increases with the dose. It is completely prevented or arrested by Atropine.

Perspiration is referable to stimulation both of the sudoriparous nerves and of the sweat centres. It follows quickly on the appearance of the salivation; is accompanied by flushing of the skin, and sometimes rigor; progresses from the head downwards; may be so profuse as to soak the bed

clothes; and lasts several hours. The body-weight necessarily falls, metabolism is stimulated, and urea is said to be excreted in the saliva and sweat. Atropine arrests this diaphoresis. It is doubtful whether the milk be increased. The hair grows more actively under a course of Jaborandi. Bronchial and nasal secretions flow more freely; even the tears, cerumen, and alimentary secretions are somewhat increased; but not the bile. The amount of urine is moderately raised at first by small doses; necessarily diminished if profuse sweating have occurred. The menses are not affected. The eye is affected specifically, as it is locally. Respiration is not modified directly by Pilocarpine. At first the heart and pulse are accelerated, but they are afterwards slowed and weakened; the vessels dilate; the blood pressure falls temporarily, then rises, and finally falls. Part of these effects is due to the action of the drug on the vagus in the heart, and can be arrested by Atropine; part to the ganglia. The temperature rises before the sweating, and falls during it.

Pilocarpine has been tried in every kind of disease, but is now chiefly used as a powerful and rapid diaphoretic, especially in nephritis with uræmia, as it eliminates both water and urea. It is less useful in effusions into the pleura and peritoneum. It must be used with caution in cardiac dropsy, and indeed in every class of case if the heart be weak. It has also been given to relieve itching by gently stimulating the skin. Bronchial catarrh, asthma, and pertussis are said to have been relieved by the flux which it establishes in the respiratory passages; but in certain cases where the irritability is low or the patient comatose this may become positively dangerous, a result that must never be despised when this powerful drug is administered. Small doses relieve the thirst of chronic Bright's disease. It has been given with success as an **antidote to Atropine.**

STERCULIACEÆ.

Oleum Theobromatis. — Oil of Theobroma. Cacao Butter. A concrete oil obtained by pressing the warm crushed seeds of Theobroma Cacao.

Characters.—A yellowish-white solid; odour like that of cocoa; taste bland and agreeable; fracture smooth; not rancid from exposure to the air. Softens at 80° F., and melts at 88° to 93° F. *Impurities.*—Other fats.

Composition.—Oil of Theobroma constitutes from 30 to 50 per cent. of the Cacao Bean, with an alkaloid *theobromine*, $C_7H_8N_4O_2$. It consists chiefly of stearin with a little olein.

Oil of Theobroma is used in preparing: Suppositoria Acidi Tannici, Hydrargyri, Iodoformi, Morphinæ, and Plumbi Composita—*i.e.* all the Suppositoria except Suppositoria Glycerini.

ACTIONS AND USES.

Cacao Butter serves as a vehicle for more active substances in the form of suppositories. The actions of Theobromine are similar to those of Caffeine. *See* page 322.

TERNSTRÖMIACEÆ.

Tea.—(*Not official.*) The dried leaves of Thea sinensis.

Composition.—Tea contains 1 to 4 per cent. of *caffeine*, $C_8H_{10}N_4O_2H_2O$; a *volatile oil*, most abundant in green tea; and *tannic acid*. The relations of the alkaloid, as well as its

ACTIONS AND USES,

are fully described under *Caffeina*, page 322.

GUTTIFERÆ.

Cambogia.—GAMBOGE. A gum-resin obtained from Garcinia Hanburii.

Characters.—Cylindrical solid or hollow rolls longitudinally striated on the surface, either distinct or agglutinated into masses; fracture conchoidal, the fractured surface dull, smooth, uniform, reddish-yellow; powder bright yellow; no odour; taste very acrid. Rubbed with water it forms a yellow emulsion. *Solubility.*—Completely by the successive action of alcohol 90 per cent. and water. *Impurities.*—Starch and mineral matter.

Composition.—Gamboge contains about 73 per cent. of a resinous substance *gambogic acid*, $C_{20}H_{23}O_4$; 25 per cent. of *gum;* and about 2 per cent. of water. Gambogic acid is insoluble in water, gives the brilliant yellow colour to the gum-resin, and forms salts with bases. It is less active than the gum-resin. *Dose*, $\frac{1}{2}$ to 2 gr.

Preparation.

Pilula Cambogiæ Composita.—Gamboge 1; Barbados Aloes, 1; Compound Powder of Cinnamon, 1; Hard soap, 2; Syrup of Glucose, q.s. *Dose*, 4 to 8 gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Gamboge is an **irritant** to the stomach and bowels, causing vomiting in large doses, and in medicinal doses acting as a **hydragogue cathartic** not unlike Colocynth, without being cholagogue. It is seldom prescribed alone, and not often as the Compound Pill. Such a remedy is indicated in dropsies, in cerebral hyperæmia, and as an anthelmintic (not to children); but other substances have now almost completely displaced it.

2. ACTIONS IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTIONS AND USES.

Gambogic acid is chiefly thrown out in the liquid fæces; but part is absorbed, passes through the blood and tissues, and is excreted by the kidneys, which it stimulates, causing an increased flow of yellow-coloured urine. The **diuretic** effect may add to the value of the drug in dropsy.

VITACEÆ.

Uvæ.—RAISINS. The ripe fruit of Vitis vinifera, the Grape Vine, dried in the sun, or partly with artificial heat.

Composition.—Raisins contain *grape sugar*, *acid potassium tartrate*, other vegetable acids, etc.

Raisins are contained in Tinctura Cardamomi Composita and Tinctura Sennæ Composita.

ACTIONS AND USES.

Raisins are **demulcent**, refreshing, and nutrient, and are employed in medicine as **sweetening** and flavouring agents.

ZYGOPHYLLACEÆ.

Guaiaci Lignum.—GUAIACUM WOOD. The heartwood of Guaiacum officinale; or of Guaiacum sanctum.

Characters.—Dark greenish-brown; dense, hard and heavier than water; taste acrid; odour, when it is heated, fairly aromatic.

Guaiaci Lignum is an ingredient of Liquor Sarsæ Compositus Concentratus.

Guaiaci Resina.—Guaiacum Resin. The resin obtained from the stem of Guaiacum officinale or of Guaiacum sanctum.

Characters.—Large masses of rounded tears, reddish-brown or yellowish-green. Powder green. Breaks with a clean glassy fracture. Odour somewhat balsamic. Taste slightly acrid. A solution in alcohol strikes a clear blue when applied to the inner surface of a raw potato (fresh protoplasm).

Substances resembling Guaiacum Resin: Myrrh, Scammony, Benzoin, Aloes, Resin; which have no green tinge.

Composition.—The chief constituent of Guaiacum Wood is the official *resin*, with a crystalline bitter colouring matter, gum, etc. The resin is itself composed of three resins: *guaiaconic acid*, $C_{19}H_{20}O_5$, 70 per cent.; *guaiac acid*, $C_1H_8O_3$, resembling benzoic acid; and *guaiaretic acid*, $C_{20}H_{26}O_4$, 10 per cent. *Incompatibles.*—Mineral acids, spirit of nitrous ether. *Dose of the Resin*, 5 to 15 gr.

Preparations.

1. **Mistura Guaiaci.**—1; Refined Sugar, 1; Powdered Tragacanth, ·16; Cinnamon Water, 40. *Dose*, ½ to 1 fl.oz.

2. **Tinctura Guaiaci Ammoniata.**—20; Oil of Nutmeg, ·31; Oil of Lemon, ·21; Strong Solution of Ammonia, 7·5; Alcohol 90 per cent. to make 100. *Dose*, ½ to 1 fl.dr. (with 1 dr. of mucilage, or with yolk of egg, to form an emulsion).

3. **Trochiscus Guaiaci Resinæ.**—3 grs. with Fruit Basis.

Guaiacum Resin is also contained in Pilula Hydrargyri Subchloridi Composita. See page 95.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Internally, Guaiacum is a **local stimulant**, producing salivation, an acrid hot sensation in the throat, warmth in the epigastrium, increase of the movements and secretions of the stomach and bowels, and reflex stimulation of the heart. In

large quantity it is a gastro-intestinal irritant, causing vomiting and purging, and the attendant disturbances of the system.

Guaiacum in powder frequently relieves sore throat, if given in 30-gr. doses, to be placed on the tongue and slowly swallowed every six hours. The Tincture and Lozenge are less successful. Plummer's Pill doubtless owes part of its mildly purgative effects to the Guaiac Resin it contains.

2. Actions in the Blood, Specific and Remote Local Actions and Uses.

The further action of Guaiacum physiologically is still obscure. Besides its **stimulant effect on the circulation**, already mentioned, it appears to increase the secretions of the skin and kidney, and it probably **stimulates the liver** and metabolism generally. In the form either of the Resin (in cachet) or of the Ammoniated Tincture it is used in chronic gout and rheumatism, certainly with much success in some cases. As a constituent of Liquor Sarsæ Compositus Concentratus, not alone, it is **given in syphilis.**

SIMARUBACEÆ.

Quassiæ Lignum.—Quassia Wood. The Wood of the trunk and branches of Picræna excelsa.

Characters.—Logs varying in length, frequently exceeding 6 inches in diameter. Wood dense, tough, yellowish-white. Inodorous; taste intensely and purely bitter.

Substance resembling Quassia: Sassafras, which is aromatic, not bitter.

Composition.—The active principle of Quassia is *quassin*, $C_{32}H_{44}O_{10}$, a white, crystalline, neutral bitter principle. Quassia contains *no tannic acid.*

Preparations.

1. **Infusum Quassiæ.**—1 in 100 of *cold* Water. *Dose*, ½ to 1 fl.oz.

2. **Liquor Quassiæ Concentratus.**—Alcoholic. 1 in 10. *Dose*, ½ to 1 fl.dr.

3. **Tinctura Quassiæ.**—1 in 10 of Alcohol 45 per cent.; by maceration. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

Quassia is a pure or **simple bitter,** and possesses the various properties fully described under *Calumba* (p. 219). It is very extensively used. The special points to be noted respecting it are: (1) that its preparations contain no tannic acid, and may be combined with salts of Iron; (2) that it is entirely devoid of flavour, and intensely bitter, *i.e.* less agreeable than Gentian and Chiretta; and (3) that the Infusion makes an excellent anthelmintic enema.

CELASTRACEÆ.

Euonymi Cortex.—Euonymus Bark. The dried root-bark of Euonymus atropurpureus.

Characters.—Quilled or curved pieces, $\frac{1}{12}$ to $\frac{1}{6}$ inch thick; the outer layer is a soft friable cork, ash-grey with dark patches; pale tawny-white and smooth within. Odour faint, characteristic; taste somewhat mucilaginous, afterwards bitter and acrid.

Composition.—Euonymus contains an intensely bitter *resin*, *asparagin* and a *fixed oil.*

Preparation.

Extractum Euonymi Siccum.—Dry Extract of Euonymus. "Euonymin." Alcoholic; incorporated with Calcium Phosphate. *Dose,* 1 to 2 gr.

ACTIONS AND USES.

Euonymus is an **hepatic stimulant, direct cholagogue and mild cathartic.** It is used in constipation and derangement of the liver.

RHAMNACEÆ.

Cascara Sagrada.—Cascara Sagrada. Rhamni Purshiani Cortex. Sacred Bark. The dried bark of Rhamnus purshianus.

Characters.—In quilled, channelled or nearly flat pieces about 4 inches long, $\frac{3}{4}$ inch wide and $\frac{1}{16}$ inch thick. Cork nearly smooth, dark purplish-brown, marked with scattered transversely elongated lenticels; but usually more or less covered with patches of silvery-grey lichen; when these are removed the exposed cork is brownish-red. Inner surface

reddish-brown, transversely corrugated and longitudinally striated. Fracture short; near the inner surface somewhat fibrous. Odour characteristic but not powerful; taste persistent, bitter, nauseous.

Composition.—A crystalline *neutral principle* and various *resinoid bodies* have been obtained from Cascara.

Preparations.

1. **Extractum Cascaræ Sagradæ.**—Aqueous. *Dose*, 2 to 8 gr.

2. **Extractum Cascaræ Sagradæ Liquidum.**—Alcoholic and aqueous. 1 in 1. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

From the Liquid Extract is prepared:

SYRUPUS CASCARÆ AROMATICUS.—4; Tincture of Orange, 1; Alcohol 90 per cent., ·5; Cinnamon Water, 1·5; Syrup, 3. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

ACTIONS AND USES.

Cascara Sagrada is **stomachic and tonic** in small doses, **aperient** in large doses, and cathartic if freely given. It is extensively used in chronic constipation. The Liquid Extract may be given in a single full dose in the morning, or in divided doses of 10 to 15 min. thrice a day, before meals.

BURSERACEÆ.

Myrrha.—MYRRH. A gum-resin obtained from the stem of Balsamodendron Myrrha, and probably other species.

Characters.—In rounded or irregular tears or masses varying much in size, reddish-yellow or reddish-brown, dry and more or less covered by a fine powder; brittle, the fractured surface irregular, somewhat translucent, rich brown, oily, often with whitish marks; odour agreeable, aromatic; taste aromatic, bitter, acrid.

Composition.—Myrrh contains *gum*, 60 per cent.; a *volatile oil*, $C_{10}H_{11}O$, *myrrhol*, 2 per cent.; and a *resin*, *myrrhin*, 35 per cent. *Impurities.*—Every variety of resin and gum-resin; detected by appearance, smell and taste. Bdellium and false myrrh; detected by absence of violet colour assumed by true myrrh when moistened with Nitric Acid.

Preparations.

1. **Pilula Aloes et Myrrhæ.**—1 in 4·5. See *Aloe Socotrina*, page 415.

2. **Tinctura Myrrhæ.**—1 in 5 with Alcohol 90 per cent.; by maceration. *Dose*, ½ to 1 fl.dr. (in emulsion).

Myrrh is also contained in Decoctum Aloes Compositum, Mistura Ferri Composita, Pilula Galbani Composita and Pilula Rhei Composita.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Myrrh is a **stimulant and disinfectant** like other oleo-resins, and is sometimes used as a dressing for ulcers.

Internally.—It exerts a similar effect upon the mouth, throat, stomach and bowels. It is much employed as a wash (2 fl.dr. of the Tincture to 4 fl.oz. of water) in spongy gums and ulcerated mouth; as a gargle in relaxed throat; and as a **stomachic and adjuvant of purgatives** in dyspepsia, anæmia and constipation.

2. ACTIONS ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTIONS AND USES.

Myrrh **increases the number of leucocytes** in the blood, apparently by stimulating lacteal activity, and this fact may in part account for its value along with Iron in anæmia. Nothing definite is known of its specific action. Like the oleo-resins (see *Terebinthinæ Oleum*, page 403), Myrrh appears to be excreted by the mucous membranes, especially the genito-urinary and respiratory tracts, and to stimulate them during its passage. It is thus a **uterine stimulant and emmenagogue**, and is extensively given along with Aloes or Iron in the amenorrhœa of girls. As a **stimulant and disinfectant expectorant** it is used less than formerly in chronic bronchitis.

LEGUMINOSÆ.

Tragacantha.—TRAGACANTH. A gummy exudation, obtained by excision from Astragalus Gummifer, and some other species known as Syrian Tragacanth in commerce.

Characters.—In white or pale yellowish-white, flattened flakes of varying length and breadth, frequently about 1 inch long and ½ an inch wide; thin, irregularly oblong or more or less curved; marked on the surface by concentric ridges. Somewhat translucent and horny; breaks with a short fracture; inodorous and almost tasteless. *Solubility.*—Sparingly in water, but swells into a gelatinous mass, which is tinged violet or blue by a solution of iodine. *Impurities.*—Other gums. After maceration in cold water, the fluid portion is not precipitated by alcohol 90 per cent. *Substance resembling Tragacanth:* Squill, which is thicker and opaque.

Composition.—Tragacanth consists of two gums: *tragacanthin* (*bassorin*), $C_{12}H_{20}O_{10}$, 33 per cent., comparatively insoluble in water, and unfermentable; and a gum nearly identical with the *arabin* of acacia (but precipitated by lead acetate), 53 per cent., soluble in water (*see* page 10). It also contains a little starch.

Preparations.

1. **Glycerinum Tragacanthæ.** — 1; Glycerin, 3; Water, 1; by trituration.

2. **Mucilago Tragacanthæ.**—A solution in Water *with the aid of* Alcohol 90 per cent.

3. **Pulvis Tragacanthæ Compositus.** — 1; Gum Acacia, 1; Starch, 1; Refined Sugar, 3. *Dose*, 20 to 60 gr.

Tragacanth is also contained in Pulvis Opii Compositus, Confectio Sulphuris, Mistura Cretæ, Mistura Guaiaci, Pilula Ferri, and Pilula Quininæ Sulphatis; *Mucilage of Tragacanth* in Lotio Hydrargyri Nigra.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Internally, Tragacanth is **demulcent.** The Mucilage may be used as a vehicle for more active substances in linctuses for pharyngeal cough. Tragacanth is partly converted into sugar by the stomach; in large quantities it causes indigestion. It is chiefly employed to suspend resins and heavy powders such as salts of Bismuth, the simple gum being preferable to the Compound Powder, because less likely to ferment.

2. ACTIONS IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTIONS.

Tragacanth, like other gums, enters the blood and tissues, partly unchanged, partly as sugar and other products, and has a nutritive effect of comparatively low value. It is not used for this purpose. A remote demulcent effect on the urinary organs is probably imaginary only.

Glycyrrhizæ Radix. — LIQUORICE ROOT. The peeled root and peeled subterranean stem of Glycyrrhiza glabra, and other species.

Characters.—In long, nearly cylindrical pieces; before being peeled, dark brown and longitudinally wrinkled but not scaly; when peeled, yellow, with a nearly smooth fibrous surface. Fracture coarsely fibrous; transverse sections exhibit a porous, distinctly radiate yellow wood and a thick cortex with groups of bast fibres arranged in radial lines. Odour faint; taste characteristic, sweet, free from bitterness. *Substances resembling Liquorice Root:* Pyrethrum and Taraxacum, which are not sweet.

Composition.—Liquorice Root contains *grape-sugar*, *glycyrrhizin*, *starch*, *resin*, *asparagin* and *malic acid*. Glycyrrhizin is a yellow amorphous glucoside, $C_{24}H_{36}O_9$, with a strong bitter-sweet taste and acid reaction, yielding glucose and a very bitter substance, *glycyrrhetin*.

Preparations.

1. **Extractum Glycyrrhizæ.**—Aqueous.

2. **Extractum Glycyrrhizæ Liquidum.** — Aqueous and Alcoholic. *Dose*, ½ to 1 fl. dr.

3. **Pulvis Glycyrrhizæ Compositus.**—2; Senna, 2; Fennel, 1; Sublimed Sulphur, 1; Refined Sugar, 6. *Dose*, 60 to 120 gr.

Liquorice or its preparations are contained in many preparations throughout the Pharmacopœia. It especially covers the tastes of Senna, Aloes, Ammonium Chloride, Senega, Hyoscyamus, Turpentine and Bitter Sulphates. The powdered root is a useful basis for pills.

ACTIONS AND USES.

Liquorice is chiefly used for the pharmaceutical purposes just indicated. It has a pleasant taste, and increases the

flow of saliva and mucus when slowly chewed or sucked. It is a popular **demulcent**, used to relieve sore throat and coughs.

Scoparii Cacumina.—Broom Tops. The fresh and dried tops of Cytisus Scoparius.

Characters.—Stem dark green, with long, straight, slender alternate branches; the latter, like the upper part of the stem, winged, tough, flexible, glabrous. The leaves, when present, are small, sessile and simple above, stalked and trifoliate below. Odour of the fresh tops, especially when bruised, characteristic; but when dry the drug is almost odourless. Taste bitter and nauseous.

Composition.—Scoparium contains two active principles, *scoparin* and *sparteine*, besides other constituents. Scoparin, $C_{21}H_{22}O_{10}$, is a yellow crystalline neutral body, said by some to be a diuretic, by others not so. Sparteine, $C_{15}H_{26}N$, is a volatile, oily-looking liquid alkaloid, allied in appearance, composition and action to conine. See *Conii Fructus*, page 299.

Preparations.

1. **Infusum Scoparii.**—1, *dried*, in 10 of boiling Water. *Dose*, 1 to 2 fl. oz.

2. **Succus Scoparii.**—3 of juice of *fresh* tops to 1 of Alcohol 90 per cent. *Dose*, 1 to 2 fl.dr.

ACTIONS AND USES.

The actions of Broom on the system are still obscure, the only fact definitely known being that it frequently produces free diuresis. Scoparin appears to be diuretic and purgative. Sparteine increases the force of the heart, and its sulphate has been given in cardiac disease in the place of Digitalis, to which, however, it is certainly inferior. Broom itself is extensively used in Great Britain as a **diuretic** in dropsy, especially cardiac dropsy, but is almost invariably combined with other drugs of the same class, such as Digitalis and Potassium Acetate. It should be avoided in acute renal dropsy.

Pterocarpi Lignum.—Red Sanders Wood. Red Sandal-wood. The heart-wood of Pterocarpus santalinus.

Characters.—Dense heavy logs ; externally dark reddish- or blackish-brown ; internally deep blood-red, variegated with lighter red zones, if cut transversely. When warmed, exhales a faint aroma ; taste very slightly astringent. *Substance resembling Red Sanders Wood:* Logwood ; less dense. *See* page 279.

Composition.—Red Sanders Wood contains a blood-red crystalline resinoid principle, *santalic acid* or *santalin*, $C_{14}H_{12}O_4$, sparingly soluble in water, soluble in alcohol 90 per cent.

USE.

Red Sanders Wood is used only to **give colour** to the Compound Tincture of Lavender.

Kino.—KINO. The juice obtained from incisions in the trunk of Pterocarpus Marsupium, evaporated to dryness.

Characters.—In small, angular, glistening, opaque, reddish-black, brittle fragments, transparent and ruby-red at the edges ; inodorous ; very astringent, tinging the saliva red. *Solubility.*—Partially in water ; almost entirely in alcohol 90 per cent.

Composition.—Kino contains 75 per cent. of *kino-tannic acid*, $C_{18}H_{18}O_8$, giving a greenish precipitate with ferric salts ; iron ; *brenzcatechin*, a derivate of catechin (see *Catechu Pallidum*, page 321) ; *kino-red*, formed from kino-tannic acid by oxydation : and *gum*. *Incompatibles.*—Mineral acids, alkalis, carbonates, metallic salts and gelatin. *Dose*, 5 to 20 gr. (in powder).

Preparations.

1. **Pulvis Kino Compositus.**—15 ; Opium, 1 ; Cinnamon Bark, 4. 1 of Opium in 20. *Dose*, 5 to 20 gr.

2. **Tinctura Kino.**—2 ; Glycerin, 3 ; Water, 5 ; Alcohol 90 per cent., to make 20 ; by maceration. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

Kino is also a constituent of Pulvis Catechu Compositus, 1 in 5.

ACTIONS AND USES.

Kino closely resembles Tannic Acid in its actions, and may be used for the same purposes. (*See* page 394.) It is chiefly employed in the form of **astringent** gargles, and as a constituent of mixtures for diarrhœa.

Balsamum Peruvianum.—Balsam of Peru. A balsam exuded from the trunk of Myroxylon Pereiræ, after the bark has been beaten and scorched.

Characters and Tests.—A viscid liquid; in bulk nearly black, in thin layers deep orange-brown or reddish-brown and transparent. Odour agreeable, balsamic; taste acrid; when swallowed, it leaves a burning sensation in the throat. *Solubility.*—Insoluble in water; soluble in chloroform; 1 in 1 of alcohol 90 per cent., but on the further addition of 2 or more volumes, turbidity occurs. Sp. gr. 1·137 to 1·150. *Impurities.*—Copaiba, resins, ethylic alcohol, castor oil and other fatty oils, gurjun balsam.

Composition.—Balsam of Peru is a complex substance. The greater part consists of (1) the *volatile oil of Peruvian balsam*, which is itself composed of cinnamin benzyl (cinnamate), $C_7H_7,C_9H_7O_2$; styracin cinnamyl (cinnamate), $C_8H_7COOC_9H_9$; peruvin (benzyl-alcohol), C_7H_7HO; benzyl benzoate, $C_7H_7C_7H_5O_2$; and styrone (cinnamic alcohol), C_9H_9HO; (2) *cinnamic acid*, $C_6H_5{\cdot}CH{\cdot}CH{\cdot}COOH$, and *benzoic acid* C_6H_5COOH in small quantities; and (3) a mixture of *resins*, probably hydrates of cinnamin. *Dose*, 5 to 15 min. (made into an emulsion with yolk of egg or mucilage of tragacanth).

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Balsam of Peru possesses the properties of its several constituents, Benzoic Acid and its allies and resins, being an **antiseptic and disinfectant, a vascular and nutritive stimulant, and a nervine sedative.** (See *Terebinthinæ Oleum*, page 401, for a full account.) Balsams have been used from time immemorial as applications to wounds and sores, but are now almost entirely displaced by simpler dressings, such as Phenol and Boric Acid. They are still used, however, to cleanse bed-sores. A more important application of Peruvian Balsam is in certain diseases of the skin, namely, (1) in some chronic inflammatory affections (eczema); (2) to **relieve itching** (prurigo, urticaria, etc.); and (3) in scabies, for which it is an excellent remedy, **killing the acarus**, relieving the itching and inflammation, and disinfecting the parts. The entire skin should be thoroughly rubbed with it (1 dr. to 1 oz. of Soft Paraffin) on two or more occasions; a warm bath being taken before, and the application washed off in the morning with Soft Soap.

Internally.—Balsam of Peru has a mild carminative effect on the stomach and bowels, like volatile oils.

2. ACTIONS ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTIONS AND USES.

The important changes undergone in the blood and tissues by benzoic and cinnamic acids, and the excretion of these and of aromatic oils by the mucous membranes, kidneys and skin, are fully discussed under *Benzoinum* (page 333), *Styrax* (page 391), and *Terebinthinæ Oleum* (page 401). The constituents of Peruvian Balsam appear chiefly to affect the respiratory organs; and it may therefore be added to cough mixtures as an agreeable **stimulant and disinfectant expectorant** in chronic bronchitis.

Balsamum Tolutanum.—BALSAM OF TOLU. A balsam that is obtained by making incisions in the trunk of Myroxylon Toluifera.

Characters.—A reddish-yellow, soft and tenacious solid, becoming hard by keeping; brittle in cold weather. Transparent, yellowish-brown in thin films. It presents microscopical crystals of cinnamic acid. Odour highly fragrant; taste somewhat aromatic and slightly acid. *Solubility.*—In alcohol 90 per cent., with an acid reaction.

Composition.—Balsam of Tolu contains a *terpene,* $C_{10}H_{16}$, *tolene; benzoic and cinnamic acids;* and various *resins.* *Dose,* 5 to 15 gr. (as an emulsion, with mucilage).

Preparations.

1. **Syrupus Tolutanus.**—1 in 38. *Dose,* $\frac{1}{2}$ to 1 fl.dr.

2. **Tinctura Tolutana.**—1 in 10 of alcohol 90 per cent.; by maceration. *Dose,* 30 to 60 min. (with mucilage).

Balsam of Tolu is also a constituent of Tinctura Benzoini Composita; *Tincture of Tolu of* Trochisci Acidi Carbolici, Morphinæ, and Morphinæ et Ipecacuanhæ; *Syrup of Tolu of* Mistura Ammoniaci.

ACTIONS AND USES.

These are the **same as those of Peruvian Balsam,** but Tolu is used internally only, and chiefly as a pleasant ingredient of cough mixtures and lozenges.

Physostigmatis Semina.—CALABAR BEAN. The ripe seeds of Physostigma venenosum.

Characters.—Large reddish-brown or chocolate-brown, oblong-reniform seeds, about 1 inch long, $\frac{3}{4}$ inch broad, $\frac{1}{2}$ inch thick. A broad dark furrow extends nearly the entire length of the curved margin. Testa hard, thick, and somewhat rough, enclosing two firm white starchy cotyledons, between which there is a large cavity. No odour, nor characteristic taste.

Composition.—Besides the ordinary constituents of beans, the seeds of Physostigma contain two alkaloids, (1) *physostigmine* or *eserine*, $C_{15}H_{21}N_3O_2$, combining with acids, and variously obtained as colourless crystals, or an amorphous or syrupy body; and (2) *calabarine*, usually mixed with commercial eserine.

Preparation.

Extractum Physostigmatis.—Alcoholic, with Milk Sugar. *Dose*, $\frac{1}{4}$ to 1 gr.

From Physostigmatis Semina is made:

Physostigminæ Sulphas.—Physostigmine Sulphate. Eserine Sulphate. $(C_{15}H_{21}N_3O_2)_2$, H_2SO_4,$x$$H_2O$.

Characters. — Yellowish-white, minute crystals, becoming red by exposure to air and light, highly deliquescent. *Solubility.*—Slightly soluble in water; soluble in alcohol 90 per cent. Aqueous solution neutral; becomes red when shaken with dilute solution of potassium hydroxide. *Dose*, $\frac{1}{60}$ to $\frac{1}{20}$ gr.

Preparation.

LAMELLÆ PHYSOSTIGMINÆ.—Discs of Gelatin, with some Glycerin, each weighing about $\frac{1}{50}$ gr., and containing $\frac{1}{1000}$ gr. of Physostigmine Sulphate.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Extract of Physostigma or preparations of Eserine are readily absorbed by the conjunctiva, and produce the specific contraction of the pupil to be presently noticed.

Taken by the mouth, Calabar Bean in moderate doses sometimes causes sickness and colic, and in larger doses diarrhœa, all from increased and irregular peristalsis, appa-

rently of local origin. The Extract is therefore occasionally used in habitual constipation.

2. Actions in the blood, and specific actions.

Eserine enters the blood unchanged, and passes thence into all the tissues. Along with the gastro-intestinal symptoms just described, moderate doses of the Bean give rise to a sense of weakness, faintness, and shortness of breath; larger doses to an aggravation of the same symptoms, with contraction of the pupil, frontal headache, salivation, diaphoresis, and slowing and weakening of the pulse. These are short of poisonous effects.

On analysis it is found that consciousness is not lost, though impaired by large doses, showing comparative freedom of the *convolutions*. The *cord* is the part principally affected by Calabar Bean, the chief symptoms being of the nature of motor paralysis from **depression of the anterior cornua,** and thus of reflex irritability also. (*Calabarine* has a *stimulant* effect on the cord, but otherwise agrees in action with Eserine.) The respiratory muscles necessarily fail from this cause. The posterior cornua (sensory portions) of the cord are paralysed to a degree, so that sensibility is diminished in the limbs. The *motor nerves* and *muscles* are but slightly affected directly. Occasional twitchings occur, partly, at least, direct in origin. The *sensory nerves* are not directly influenced.

The *medulla* is decidedly affected by Physostigma. Thus **the respiratory centre,** after brief (probably reflex) stimulation, **is depressed,** and death occurs chiefly by asphyxia. The cardiac centre is first stimulated, so that the heart beats more powerfully and less frequently; but at last, or after large doses, depression ensues. Therewith the intracardiac branches of the vagus are probably stimulated at first, and the ganglia paralysed at last. The blood-pressure rises with the increased cardiac action, and falls later. Whether there be any direct action of Eserine on the vaso-motor apparatus is unsettled.

Contraction of the pupil and spasm of accommodation are striking and highly important effects of Eserine, whether it be given internally or applied locally. Both phenomena are due to **irritation of the fibres of the third nerve,** and not to central disturbance as in the contraction caused by Opium, nor to paralysis of the sympathetic. They are accompanied by **fall of the intraocular tension**, and can be removed by Atropine.

The salivary secretion is increased by stimulation of the terminations of the secretory nerves, but ceases after large doses from arrest of the circulation in the glands.

3. SPECIFIC USES.

The specific *uses* of Calabar Bean depend on its action on the cord and the eye. It has been frequently given in tetanus, and other convulsive diseases referable to irritation or disease of the spinal centres, and apparently with success, although many cases recover spontaneously and others resist the Eserine. The Sulphate of the alkaloid should be given subcutaneously in doses of gr. $\frac{1}{60}$ to $\frac{1}{12}$ in solution; or gr. $\frac{1}{3}$ of the Extract, rubbed up with spirit, gum, and water, may be given subcutaneously, or gr. 1 by the mouth, repeated in two hours, and followed by doses of gr. $\frac{1}{16}$ to $\frac{1}{4}$ every few hours. For the convulsions of Strychnine poisoning Calabar Bean is of little or no use. Neither is it of much real service in the treatment of poisoning by Atropine or Chloral Hydrate, as was once expected.

In diseases of the eye Eserine is now much used. A drop of a solution of the Sulphate (2 gr. to 1 fl.oz. of water) is applied locally to diminish intraocular pressure in glaucoma, perforating keratitis, etc.; in paralysis of the iris and ciliary muscle, *e.g.* after diphtheria ($\frac{1}{2}$ gr. to 1 fl.oz.); to counteract the effects of Atropine; or to diminish the entrance of light in painful diseases of the eye, photophobia, etc. The Lamellæ Physostigminæ, inserted beneath the lids, are a convenient form for ophthalmic purposes.

4. REMOTE LOCAL ACTIONS.

Eserine is excreted by the liver and salivary glands, but has never been found in the urine.

Araroba.—ARAROBA. Goa Powder; Crude Chrysarobin.

Source.—Found in cavities in the trunk of Andira Araroba, freed as much as possible from fragments of wood, dried and powdered.

Characters.—From brownish-yellow to umber-brown in colour. Should yield to hot chloroform not less than 50 per cent. of a substance which, on evaporation, drying and powdering, should have the characters of Chrysarobin.

From Araroba is prepared:

Chrysarobinum.—CHRYSAROBIN.

Source.—Obtained from Araroba by extracting with hot chloroform evaporating to dryness and powdering. *Characters.*

—A crystalline yellow powder, inodorous, tasteless. *Solubility.*—Entirely in hot chloroform, almost entirely in hot alcohol 90 per cent., partially in petroleum spirit, only slightly in water. In solution of potassium hydroxide it partially dissolves and assumes a deep brownish-red colour. *Composition.*—Consists of a chemical substance also known as chrysarobin, but contains a varying proportion of chrysophanic acid.

Chrysarobin, $C_{30}H_{26}O_7$, is converted into *chrysophanic acid*, $C_{10}H_8O_3$, by slow oxydation, or by solution in strong potash and decomposition with a mineral acid. Chrysophanic acid is also contained in Rhubarb. See *Rhei Radix*, page 372.

Preparation.

Unguentum Chrysarobini.—1 to 24 of Benzoated Lard.

ACTIONS AND USES.

Externally. — Chrysarobin **destroys low vegetable organisms in connection with the skin,** stains it purple-red, and **stimulates** it so much as to produce in some instances serious constitutional disturbance. It is a successful application in some forms of ringworm, and in scaly and other diseases of the skin, especially psoriasis. When applied over an extensive area of the skin it is apt to cause vomiting, purging, and fever. Chrysarobin is excreted by the kidneys and stains the urine yellow.

Senna Alexandrina.—Alexandrian Senna. The dried leaflets of Cassia acutifolia.

Characters.—About ¾ to fully 1¼ inch long, lanceolate or oval-lanceolate, acute, *unequal at the base*, entire, thin, brittle; pale greyish-green; distinctly veined on the lower surface; finely pubescent. Odour peculiar, faint; taste mucilaginous, unpleasant. *Impurities, and substances resembling Senna:* Solenostemma Argel, Uva Ursi, and Buchu, all equal at the base.

Senna Indica.—East Indian Senna. Tinnivelly Senna. The dried leaflets of Cassia angustifolia. From plants cultivated in Southern India.

Characters.—About 1 to 2 inches in length, lanceolate acute, *unequal at the base*, thin, entire; yellowish-green and smooth above, somewhat duller beneath; glabrous or slightly pubescent. In odour and taste similar to Alexandrian Senna.

Composition.—Senna contains an active principle, *cathartic acid;* a colouring matter closely allied to *chrysophanic acid;* a peculiar unfermentable sugar, *catharto-mannite;* other obscure glucosides, *sennapicrin* and *sennacrol;* and various vegetable salts. Cathartic acid, a highly important body, is an amorphous glucoside, $C_{180}H_{192}N_{82}SO_2$, which forms salts with bases, and can be broken up into glucose and cathartogenic acid.

Preparations of either kind of Senna.

1. **Confectio Sennæ.**—Senna, 7; Coriander Fruit, 3; Figs, 12; Tamarinds, 9; Cassia Pulp, 9; Prunes, 6; Extract of Liquorice, 1; Refined Sugar, 30; Water *q.s.* to make 75. *Dose*, 60 to 120 gr.

2. **Infusum Sennæ.**—1 in 10, with ·0625 of Ginger. *Dose*, ½ to 1 fl.oz.; as a draught, 2 fl.oz.

From Infusum Sennæ is prepared:

MISTURA SENNÆ COMPOSITA. — "Black Draught." Infusion of Senna, 11; Magnesium Sulphate, 5; Liquid Extract of Liquorice, 1; Compound Tincture of Cardamoms, 2; Aromatic Spirit of Ammonia, 1. *Dose*, 1 to 2 fl.oz. as a draught.

3. **Liquor Sennæ Concentratus.**—1 in 1. Aqueous and alcoholic, with Tincture of Ginger. *Dose*, ½ to 1 fl.dr.

4. **Syrupus Sennæ.**—Senna, 1200; Oil of Coriander, ·6; Refined Sugar, 1500; Alcohol, 90 per cent., ·4; Alcohol, 20 per cent., 2100; Water, *q.s.*; by maceration and evaporation. *Dose*, ½ to 2 fl.dr.

5. **Tinctura Sennæ Composita.**—Senna, 8; Raisins, 4; Caraway and Coriander, of each 1; Alcohol, 45 per cent., to make 40. By maceration. *Dose*, ½ to 1 fl.dr. repeated; 2 to 4 fl.dr. at once.

Senna is also the most important ingredient in **Pulvis** Glycyrrhizæ Compositus. 1 in 6. *See* page 269.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Given *internally*, Senna **stimulates the muscular coat of the intestine**, apparently by local reflex action originating in the mucous surface of the bowel itself; and **produces** brisk peristaltic movements and **purgation** within **four or five hours.**

The colon is chiefly stimulated, hurrying downwards the fluid contents received from the ileum, which appear as very thin copious yellow stools, with excess of sodium salts and digestive products, but no special increase of bile. Full doses cause repeated evacuation and griping, but no inflammation of the mucous surface. The pelvic structures may, however, become hyperæmic, leading to hæmorrhoids and the appearance of the menses. Constipation does not follow the use of Senna.

Senna is never given alone, but always with a carminative to prevent griping, and frequently with other purgatives, as in the Compound Mixture. It is one of the most useful of aperients. It is very extensively prescribed to complete the effect of mercurial and other duodenal purgatives, given several hours before. It affords at once a rapid and safe purge at the commencement of febrile attacks in children, in local inflammations, and in cerebral congestion. As an habitual laxative in the form of Pulvis Glycyrrhizæ Compositus, Senna is most valuable, being a simple stimulant of the muscular coat, which neither loses its effect by use nor produces subsequent constipation. Combined with bitter and other stomachics, it is employed in dyspepsia, the laxative effect of free cathartic acid naturally being increased by acids and diminished by alkalis.

2. Actions in the Blood, Specific and Remote Local Actions.

Cathartic acid and chrysophanic acid enter the blood, pass through the tissues, and are excreted by the kidneys and mammary gland; the cathartic acid purging infants at the breast, the chrysophanic acid staining the urine yellow. Senna acts as a purgative in animals when injected into the veins.

Hæmatoxyli Lignum.—Logwood. The heart-wood of Hæmatoxylon campechianum.

Characters.—The wood is hard, heavy, externally dull orange to purplish-red; internally reddish-brown. The chips or coarse powder (unfermented) have a feeble agreeable odour, and a sweetish astringent taste. A small portion chewed imparts to the saliva a pink colour.

Substance resembling Logwood: Red Sanders Wood, which is more dense, and less astringent to taste.

Composition. — Logwood contains *tannic acid*, and a peculiar colouring principle, *hæmatoxylin*, $C_{16}H_{14}O_6$, occurring in colourless crystals, which become red on exposure to light; the solutions undergoing various changes of colour with acids and alkalis, and coagulating gelatin. The Decoction precipitates ferric salts violet-blue, lead acetate and other metallic salts a beautiful blue. Other less important substances occur in logwood. *Incompatibles.*—Mineral acids, metallic salts, lime water, and tartar-emetic.

Preparation.

Decoctum Hæmatoxyli.—1 in 20, with about $\frac{1}{8}$ of Cinnamon Bark. *Dose*, $\frac{1}{2}$ to 2 fl.oz.

ACTIONS AND USES.

Logwood possesses the **astringent** action of Tannic Acid, and may be used in the same class of cases. It colours the urine dark red. *See* page 394.

Cassiæ Pulpa.—CASSIA PULP. The pulp obtained from the pods of Cassia Fistula.

Characters of the pods.—Nearly cylindrical; $1\frac{1}{2}$ to 2 feet long, $\frac{3}{4}$ to 1 inch wide; shortly stalked; blackish-brown; very hard; indehiscent, the sutures being marked by two smooth longitudinal bands. Divided by transverse septa into numerous cells, each containing a smooth, flattish, oval reddish-brown seed and viscid pulp. The *pulp*, alone official, is nearly black, viscid, with a sweet taste and faint odour.

Composition.—Cassia Pulp contains *sugar*, pectin, mucilage, and *a purgative principle* probably allied to *cathartic acid*. See *Senna*, page 278.

Cassia Pulp is contained in Confectio Sennæ, about 1 in 8.

ACTIONS AND USES.

Cassia Pulp is a **laxative**, given only in Confection of Senna.

Tamarindus.—TAMARINDS. The fruits of Tamarindus indica, freed from the brittle outer part of the pericarp and preserved with sugar.

Characters.—A reddish-brown, moist sugary mass, containing strong branched fibres, and brown shining seeds, each enclosed in a tough membranous endocarp. Taste agreeable, refreshing, subacid. *Impurity.*—Copper; a piece of bright iron left in the pulp for an hour should not exhibit any deposit of copper.

Composition.—Tamarinds contain *sugar, gum, tartaric acid* and *potassium tartrate;* also *citric, acetic* and various *aromatic acids.*

Tamarinds are contained in Confectio Sennæ, about 1 in 8.

ACTIONS AND USES.

Tamarinds are a pleasant acid **refrigerant** and gentle **laxative.** For the former purpose they are prepared as an infusion, or as Tamarind Whey (1 part of the pulp to 30 parts warm milk), which is also a mild purgative, like the Confection of Senna.

Copaiba.—COPAIBA. Copaiva. The oleo-resin obtained from the trunk of Copaifera Langsdorfii, and other species of Copaifera.

Characters.—A more or less viscid liquid; generally transparent, occasionally opalescent and slightly fluorescent; light yellow to pale golden brown; odour peculiar, aromatic; taste persistent, acrid, somewhat bitter. Sp. gr. 0·916 to 0·993. *Solubility.*—Insoluble in water; soluble in ether, absolute alcohol, fixed and volatile oils, and benzol; 1 in 4 of petroleum spirit.

Composition.—Copaiba consists of at least 40 per cent. of the official *volatile oil,* and more than 50 per cent. of *resin.* Oil of Copaiba, isomeric with turpentine, $C_{10}H_{16}$, is colourless or pale yellow, with the odour and taste of Copaiba. Resin of Copaiba is a brownish resinous mass, consisting of a crystallisable resin, *copaivic acid,* $C_{10}H_{30}O_2$, the chief constituent of the oleo-resin, and a non-crystallisable *viscid resin of copaiva,* amounting to $1\frac{1}{2}$ per cent. The proportion of oil and resin varies much with the age and exposure of the Copaiba. *Impurities.*—Turpentine; detected by the odour on heating. Fixed oils; leaving a greasy ring round the resinous stain when heated on paper. Copaiba dissolves $\frac{1}{4}$ its weight of magnesium carbonate by the aid of heat, and remains transparent (magnesium copaivate); fixed oils not so. Gurjun

balsam, coagulating at 270°; Copaiba not so. *Dose*, ½ to 1 fl.dr. (in emulsion or in capsules).

From Copaiba is made:

Oleum Copaibæ.—The oil distilled from Copaiba.

Characters.—Colourless or pale yellow; odour and taste of copaiba. Sp. gr. 0·900 to 0·910. Turns ray of polarised light to left. *Solubility.*—1 in 1 of absolute alcohol (distinction from African copaiba oil). *Dose*, 5 to 20 min. (with mucilage or yolk of egg).

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS.

Copaiba produces an acrid nauseous sensation in the mouth, warmth in the stomach, unpleasant eructations and gastro-intestinal irritation like other oleo-resins. Large doses or the persistent use of the drug leads to dyspepsia, sickness and diarrhœa; it is contra-indicated in irritable states of the stomach and bowels.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS, AND REMOTE LOCAL ACTIONS AND USES.

The active principles of Copaiba are absorbed into the blood, and pass thence into the tissues. Its actions on the organs are obscure. The volatile oil is excreted by the kidneys, bronchi and skin, and the resin at least by the kidneys. All the secretions smell freely of the drug, and the neighbourhood of the patient is pervaded with a characteristic unpleasant odour. In thus passing through the eliminating organs, Copaiva stimulates them, altering their secretions and the nutrition of their cells and vessels. The urine is passed more frequently, and usually in increased quantity: but it may be scanty, with albumen and blood, pain in the loins, and other symptoms of renal congestion. The albumen thus passed must be distinguished from the acid resin of Copaiba which may be thrown down from the urine by nitric acid, and which is dissolved by heat or alcohol. Carried by the urine into the bladder and urethra, and possibly also excreted by the mucous membranes of the same parts, **Copaiba produces along the whole genito-urinary tract a stimulant and disinfectant effect.** A similar influence is produced in the bronchi; the mucous secretion is increased, and **expectoration reflexly excited.** The stimulation of the skin (and probably the

primary gastro-intestinal irritation in part) may sometimes cause an eruption, the "Copaiva rash," not unlike that of measles.

The uses of Copaiba depend entirely on its remote local effects, the immediate local effects only suggesting care in its administration. Its chief application is to the genito-urinary organs. The resin is given in doses of 5 to 15 gr., suspended in Almond Mixture, as a **diuretic** in hepatic and cardiac **dropsy,** but not in the dropsy of Bright's disease. The Oleo-resin is not used for this purpose, but is chiefly employed in inflammatory affections of the bladder and urethra, especially gonorrhœa, when the first acute symptoms may have somewhat subsided. Naturally it is less useful in vaginitis. Copaiba is now seldom used in bronchial affections, on account of the unpleasant effects attending it; but it will sometimes diminish and disinfect the profuse foul products of chronic bronchitis and bronchiectasis when other means have failed. It is occasionally given in skin diseases.

Acaciæ Gummi.—Gum Acacia. A gummy exudation from the stem and branches of Acacia Senegal, and of other species of Acacia.

Characters.—In spheroidal or ovoid tears or masses, nearly colourless, or with a yellowish tint, opaque from numerous minute cracks, and brittle, with vitreous fractures; or in angular fragments with shining surfaces. Nearly inodorous; bland and mucilaginous in taste. *Solubility.*—Insoluble in alcohol 90 per cent.; entirely soluble in water forming a faintly acid viscid solution. *Impurities.*—Starch, "dextrin," tannic acid, sugars and mineral matters.

Composition.—Gum Acacia consists chiefly of *arabic acid*, or *arabin*, $C_6H_{10}O_5$, combined with calcium, magnesium and potassium; and 17 per cent. of water. *Incompatibles.*—Alcohol and sulphuric acid. Borax, ferric salts, and lead subacetate render it gelatinous.

Preparation.

Mucilago Acaciæ.—Gum, 4; Water, 6.

Gum Acacia is also contained in Pulvis Amygdalæ Compositus, Pulvis Tragacanthæ Compositus, Pilula Ferri, Pilula Phosphori, and in all Trochisci.

Mucilage of Acacia is used in preparing Mistura Olei Ricini and the Lozenge Bases.

ACTIONS AND USES.

Acacia possesses properties and physiological effects **similar to those of Tragacanth**, and is employed for the same purposes (page 268). An objection to its pharmaceutical use is its liability to undergo fermentation, and cause indigestion and diarrhœa. Its principal application therapeutically is for cough, in the form of lozenges and linctuses.

ROSACEÆ.

Rosæ Gallicæ Petala. — Red Rose Petals. The fresh and dried unexpanded petals of Rosa gallica. From cultivated plants.

Characters.—Usually in little cone-like masses, sometimes separate and crumpled. Petals velvety; colour deep purplish-red, retained after drying; odour fragrant, developed in drying; taste somewhat bitter, feebly acid and astringent.

Composition.—Red Rose Petals contain an *aromatic volatile oil*, *tannic* and *gallic acids*, gum, colouring matters, salts, etc. *Oleum rosæ* exists in very small quantity; it consists of an aromatic elæoptene, *rhodinol*, $C_{10}H_{14}O$, and an odourless solid rose-camphor, $C_{18}H_{16}$.

Preparations.

1. **Confectio Rosæ Gallicæ.**—1 of *fresh* Petals to 3 of Sugar.

Confectio Rosæ Gallicæ is used as an excipient in Pilula Aloes Barbadensis, Pilula Aloes et Asafetidæ, Pilula Aloes Socotrinæ, and Pilula Hydrargyri.

2. **Infusum Rosæ Acidum.**—1 of *dried* Petals in ·5 of Diluted Sulphuric Acid and 40 of boiling Water. *Dose*, ½ to 1 fl.oz.

3. **Syrupus Rosæ.**—1, *dried*, in 23, with Sugar and Water; by solution and infusion. *Dose*, ½ to 1 fl.dr.

Oleum Rosæ.—Oil of Rose. Otto of Rose. The oil distilled from the fresh flowers of Rosa damascena.

Characters.—Pale yellow, crystalline semi-solid; odour strong and fragrant; taste sweet. Sp. gr. 0·856 to 0·860 at 86° F.

Oleum Rosæ is contained in Unguentum Aquæ Rosæ.

Aqua Rosæ.—Rose Water.—To be diluted immediately before use with twice its volume of Distilled Water.

Source.—Prepared by distillation from the flowers of Rosa damascena.

Preparation.

Unguentum Aquæ Rosæ.—"Cold Cream." Oil of Rose, ·5; White Beeswax, 45; Spermaceti, 45; Almond Oil, 270; Rose Water, undiluted, 210.

Rose Water is contained in Mistura Ferri Composita and the Rose Basis for lozenges.

ACTIONS AND USES.

The preparations of the Red and the Damask Rose are chiefly used as pleasant **vehicles.** The Acid Infusion is an agreeable astringent.

Amygdala Dulcis.—Sweet Almond. The ripe seed of Prunus Amygdalus, *var.* dulcis. Known as the Jordan Almond.

Characters.—About an inch in length, nearly oblong, pointed at the one end, rounded at the other; compressed; testa cinnamon brown, thin, rough. Seed exalbuminous, with two large plano-convex oily cotyledons. Taste bland. Triturated with water forms a white odourless emulsion. *Impurity.*—The bitter almond, which yields odour of HCN when bruised with water.

Amygdala Amara.—Bitter Almond. The ripe seed of Prunus Amygdalus, *var.* amara.

Characters.—Resembles the Sweet Almond in general appearance, but is broader and shorter, has a very bitter taste, and when rubbed with water emits an odour like ratafia.

Composition.—Both varieties of Almond yield by expression about 50 per cent. of *fixed* oil, Oleum Amygdalæ, and albuminous substances including *emulsin.* The bitter variety also yields, by distillation with water, a *volatile* oil, Oleum Amygdalæ Amaræ, Essential Oil of Bitter Almonds, C_6H_5COH, not official. The two oils must be carefully distinguished, inasmuch as the crude form of "Bitter Almond Oil" generally sold is highly poisonous, from admixture with 4 to 8 per cent. of hydrocyanic acid. Bitter Almonds contain neither the volatile oil nor hydrocyanic acid until moistened, but 2 to 3 per cent. of *amyg-*

dalin, $C_{20}H_{27}NO_{11}$, a crystalline glucoside, which, in the presence of water, and under the fermentative influence of the emulsin, breaks up into the volatile oil, hydrocyanic acid, and glucose: $C_{20}H_{27}NO_{11} + 2H_2O = C_6H_5COH + HCN + 2C_6H_{12}O_6$. When purified by separation of the hydrocyanic acid, Volatile Oil of Bitter Almonds is not poisonous, consisting, as it does, of benzol hydride (C_7H_5OH), with benzoic acid ($C_6H_5.COOH$) as a product of oxydation by exposure, and other allied substances; and is used for flavouring sweets. Nitrobenzene, however, artificial Oil of Bitter Almonds, or "Nitrobenzol," $C_6H_4(NO_2)H$, which is sometimes substituted for it, having a very similar flavour, is decidedly poisonous, and has caused death.

Preparation of the Sweet Almond.

Pulvis Amygdalæ Compositus.—Sweet Almonds, blanched, 8; Refined Sugar, 4; Gum Acacia, 1.

From Compound Powder of Almonds is prepared:

MISTURA AMYGDALÆ.—1; Water, 8. *Dose*, ½ to 1 fl.oz.

From either Bitter or Sweet Almond is made:

Oleum Amygdalæ.—Almond Oil. The oil *expressed* from the Bitter or Sweet Almond.

Characters.—Pale yellow, nearly inodorous, with a bland nutty taste. *Solubility.*—In all proportions of Ether and Chloroform. Sp. gr. 0·915 to 0·920. Congeals below −4° F. *Impurities.*—Various fixed oils.

Almond Oil is contained in Linimentum Ammoniæ, Oleum Phosphoratum, Unguentum Cetacei, and Unguentum Aquæ Rosæ. It is used in preference to Olive Oil, as it makes a whiter ointment.

ACTIONS AND USES.

The Sweet Almond is **demulcent and nutritive,** and has been ground into a flour for making cakes to be eaten by diabetic patients, instead of starchy food. The Compound Powder and Mixture are used only as **vehicles** for insoluble powders and oils and in demulcent cough medicines.

Almond Oil has the same action, and is used for the same purposes, as Olive Oil, which, though less agreeable, is generally employed as being cheaper. See *Oleum Olivæ*, page 337.

Prunum.—Prunes. The dried ripe fruits of Prunus domestica, *var.* Juliana.

Characters.—Ovoid or oblong; about 1¼ inch long; black; shrivelled; pulp brownish, without marked odour; taste sweet, bland and acidulous.

Composition.—The prune contains *sugar*, *malic acid* and a purgative principle.

Prunes are contained in Confectio Sennæ, 6 in 75.

ACTIONS AND USES.

The Prune is **nutritive, demulcent and slightly laxative,** and is also useful in covering the taste of Senna. It may be ordered as an article of diet in habitual constipation.

Pruni Virginianæ Cortex.—Virginian Prune Bark. The bark of Prunus serotina, collected in autumn.

Characters.—In curved pieces or irregular fragments ½ inch or more thick. Young bark frequently covered with a smooth, thin, reddish-brown, papery cork, or, if this has been removed, exhibiting a greenish-brown inner layer; it is marked with transversely elongated lenticels and breaks with a short granular fracture. Outer surface of old bark usually rough and nut-brown; inner surface finely striated or fissured and reticulated; fracture surface reddish-grey. Odour, which is developed upon maceration in *water*, resembles that of the bitter almond; taste astringent, aromatic, bitter.

Composition.—Virginian Prune contains a *volatile oil* and also *amygdalin* and *emulsin* which, under the influence of water, yield by their interaction hydrocyanic acid (*see* page 285).

Preparations.

1. **Syrupus Pruni Virginianæ.**—A cold *aqueous* solution, obtained by maceration and percolation; with Refined Sugar, Glycerin and Water. *Dose*, ½ to 1 fl.dr.

2. **Tinctura Pruni Virginianæ.**—1 in 10 with *Water* and Alcohol 90 per cent.; by maceration. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

The important constituents of Virginian Prune are the aromatic oil by virtue of which it is **a flavouring agent,**

and the prussic acid with its sedative action which is developed by the special methods employed for preparing the Syrup and Tincture. These form pleasant and useful ingredients of mixtures and linctuses intended to relieve cough in a variety of diseases of the respiratory organs.

Laurocerasi Folia.—Cherry-Laurel Leaves. The fresh leaves of Prunus Laurocerasus.

Characters.—Thick, coriaceous, on short strong petioles; oblong or somewhat obovate; 5 to 7 inches long; tapering towards each end, recurved at apex; distantly but sharply serrate and slightly revolute at margins; dark-green, smooth, and shining above, much paler beneath, with prominent mid-rib, on either side of which, towards the base, are 1 or 2 glandular depressions. On bruising, they emit a ratafia-like odour.

Composition.—Cherry-Laurel Leaves yield by distillation a variable amount of *hydrocyanic acid* and a *volatile oil*, by a process of decomposition resembling that described under Bitter Almond (page 285). Neither emulsin nor ordinary amygdalin has, however, been demonstrated in the leaves, but a resinoid body, which with emulsin yields hydrocyanic acid, and is called "*amorphous amygdalin.*"

Preparation.

Aqua Laurocerasi.—Cherry-Laurel Water. 1 in $1\frac{1}{4}$ by distillation, and *standardised* by the addition either of Water or of Hydrocyanic Acid to the distillate, so as to adjust the strength to 0·1 per cent. of Hydrocyanic Acid, as tested volumetrically with $AgNO_3$. *Incompatibles:* metallic salts. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

ACTIONS AND USES.

Cherry-Laurel Water possesses the actions of Diluted Hydrocyanic Acid, and is also a **flavouring agent.** *See* page 192.

Cusso.—Kousso. The dried panicles of pistillate flowers of Brayera Anthelmintica.

Characters.—In more or less cylindrical rolls, from 1 to 2 feet long, consisting of reddish panicles of pistillate flowers. The panicles much branched, the branches arising from the axils of large sheathing bracts; they are more or less covered with hairs and glands. Flowers numerous, small, shortly stalked, mostly unisexual, with two roundish membranous veined bracts at the base of each. The calyx has reddish veins, is hairy externally, and consists of two alternating whorls, each of five segments, the inner whorl curved inwards over the young fruit and shrivelled. No marked odour; taste bitter and acrid.

Composition.—Kousso contains a *volatile oil*, *tannic acid*, *gum*, *sugar*, and a neutral crystallisable active principle, *koussin* or *cossin*, $C_{31}H_{38}O_{10}$, soluble in alkaline solutions. *Dose*, $\frac{1}{4}$ to $\frac{1}{2}$ oz.

ACTIONS AND USES.

Taken in the large doses necessary, Kousso is apt to cause nausea, vomiting, colic and slight diarrhœa. Its principal action is as an **anthelmintic**, the tape-worms (Tænia solium, Tænia mediocanellata, and Bothryocephalus latus) being readily killed by it. It is used for this purpose only, and rarely in Britain. It may or may not require the assistance of a purgative to expel the dead worm. The powdered flowers, either in compressed masses or suspended in an aromatic water, are said to be much more active than an infusion.

Quillaiæ Cortex.—Quillaia Bark. Panama Bark. The inner part of the bark of Quillaja saponaria.

Characters.—Usually imported in large flat pieces, about $\frac{1}{8}$ inch thick, 2 feet or more long, and 4 inches wide. Outer surface brownish-white, or, where the outer bark has been imperfectly removed, reddish-brown or blackish-brown; inner surface smooth and white or yellowish-white. Fracture splintery; fractured surface laminated, exhibiting under a lens glistening prismatic crystals; transverse section marked with fine radial and tangential lines. Taste astringent and acrid; odour not marked, but the powder is extremely irritating to the nostrils.

Composition.—Quillaia Bark contains *saponin* (*see* page 245) and other substances.

Preparation.

Tinctura Quillaiæ.—1 in 20 with Alcohol 60 per cent.; by percolation. *Dose*, ½ to 1 fl.dr.

Quillaia Bark is also contained in Liquor Picis Carbonis (*see* page 205).

ACTIONS AND USES.

Quillaia Bark possesses the property of **emulsifying** oils, resins, etc. By virtue of the saponin which it contains it is an **expectorant** like Senega; and it is used in various combinations, including Solution of Coal Tar, for the treatment of bronchitis and other diseases of the respiratory organs.

MYRTACEÆ.

Caryophyllum.—CLOVES. The dried flower-buds of Eugenia caryophyllata.

Characters.—Over ½ an inch long, consisting of a dark-brown, wrinkled, subcylindrical, somewhat angular calyx tube, tapering below, and surmounted by four teeth, between which are four paler, imbricated petals, enclosing the stamens and style. Odour strong, fragrant, spicy; taste very pungent, aromatic. Emits oil when indented.

Composition.—Cloves contain 20 per cent. of the official volatile *oil*, tannic acid, and gum. A crystalline body, *eugenin*, isomeric with eugenol; a neutral body, *caryophyllin*, isomeric with camphor; and a salicyl compound, can also be obtained from Cloves.

Preparations.

Infusum Caryophylli.—1 in 40 of boiling Water. *Dose*, ½ to 1 fl.oz.

Cloves are also contained in Infusum Aurantii Compositum and Pulvis Cretæ Aromaticus.

From Caryophyllum is made:

Oleum Caryophylli.—Oil of Cloves. The oil distilled from Cloves.

Characters.—Colourless or pale yellow, when recent, becoming red-brown; with the odour and taste

of Cloves. Sp. gr. not below 1·050. It is one of the few volatile oils heavier than water.

Composition.—Oil of Cloves consists of *eugenol* (eugenic acid), $C_{10}H_{12}O_2$, chemically resembling Phenol, and a terpene, $C_{15}H_{24}$. *Dose*, ½ to 3 min.

Oil of Cloves is contained in Pilula Colocynthidis Composita, and Pilula Colocynthidis et Hyoscyami.

Incompatibles.—Lime water, salts of iron, mineral acids and gelatin.

ACTIONS AND USES.

Cloves may be taken as the type of a great group of remedies, other members of which are Orange, Lemon, Pimento, Cajuput, Caraway, Dill and many more, which are met with in our systematic review of medicinal plants. This group is known as the **Aromatic Volatile Oils**, of complex and variable chemical composition, as described at page 9. They are closely allied, on the one hand, to Phenol and Benzoic Acid; on the other hand, to still more complex vegetable products, the Balsams and Gum-resins. Instead of dislocating the various members of the group of aromatic oils from their proper botanical position to discuss them together, we will describe their actions and uses once for all under the present head, it being understood that what is said of Oil of Cloves applies to the other substances, with occasional qualifications.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, Oil of Cloves and allied substances closely resemble Turpentine in their properties. Whilst **preventing or arresting decomposition**, they redden and inflame the skin, and cause for a time smarting pain, which gives place to local anæsthesia. Oil of Cloves and other fragrant oils are too costly to be used externally, except to scent liniments; but the concrete "oils" (or solid constituents of the oils) of Peppermint, Thyme, Eucalyptus, Myrtle, etc. (stearoptenes), are excellent **antiseptics, local anæsthetics, stimulants and counter-irritants**, and Turpentine and Camphor are common applications for these purposes. Such aromatic substances might be used to disinfect foul wounds and ulcers, and promote healing; to hasten the removal of chronic inflammatory products by increasing the local blood flow, and thus to reduce swelling in or under the skin, the periosteum or the joints to relieve neuralgic and rheumatic pains, such as

sciatica and lumbago, by dulling the sensibility of the nerves; and to act reflexly on deeper parts (for instance, the lungs or heart), when applied to the skin over them as counter-irritants.

Internally.—In the *mouth* the aromatic Oils of Cloves and their allies act much as they do on the skin. Besides being antiseptic, they dilate the local vessels (? directly), and thus increase the circulation, heat, and nutrition, and may even cause inflammation. They irritate the nerves, causing pain associated with a sense of burning; but depression quickly follows, and local anæsthesia. Oil of Cloves is a valuable application in toothache from dental caries, acting at once as an anodyne and disinfectant. At the same time, the nerves of **taste and smell (flavour) are powerfully excited.** Several *reflex* results, of the first importance in digestion, follow these local changes, namely: (1) salivation; (2) a flow of mucus; (3) hyperæmia of the gastric mucosa, a sense of hunger, and a flow of gastric juice. Therewith there occur (4) stimulation of the appetite and increase of relish by the pleasing flavour. In a word, aromatics produce **an increased desire for, enjoyment of, and digestion of food.**

Aromatic Oils are accordingly used very extensively in cookery, where the proper use of them constitutes an important portion of the culinary art. Those of them which are also associated with bitters, such as Orange, are taken with wines and spirits as various "aromatic bitters," liqueurs, etc., to rouse or strengthen appetite and digestion before or during a meal. In pharmacy they are employed to correct the tastes of nauseous drugs; and therapeutically they are given in dyspepsia and debility along with most bitters to increase the saliva and the gastric juice.

In the *stomach* the effect of Aromatics on the vessels and nerves is continued. Besides causing an increased flow of juice by stimulation of the mouth, these substances are powerful **stomachics** in several ways. The vessels of the mucosa are dilated; the nerves of the same are first excited (causing a sense of heat in the epigastrium) and then soothed, with relief of pain; the contents, if decomposing, as in dyspepsia, are partly disinfected. Their *reflex* influence is equally important. The muscular coat is stimulated, with increase of gastric movements, and the cardiac orifice is perhaps relaxed: Aromatics thus expelling flatulence, and relieving painful cramps, spasms, hiccup, and other forms of distress, an effect generally described as **carminative.** Distant organs are also reflexly stimulated: the vigour of the heart is increased, the blood-pressure is raised, and the spinal, the

medullary, and even the cerebral centres are temporarily excited, to the relief of low, hysterical, and "spasmodic" symptoms, as well as of more serious conditions such as asthma, cardiac pain and palpitation. Aromatics are thus **general stimulants and antispasmodics.**

In the *intestines* the Aromatic Oils may still be found partly unabsorbed, acting on the same structures as before, increasing the local circulation and secretions, stimulating the intestinal movements, and expelling flatus. They thus relieve or prevent pain or spasm (colic), and provide us with valuable **correctives** of the griping tendencies of many purgatives. The constitution of the most important compound pills, powders, and laxative draughts should be studied in this connection, such as Pilula Rhei Composita, Pulvis Jalapæ Compositus, and Mistura Sennæ Composita. Caryophyllum is slightly astringent, by virtue of its Tannic Acid.

2. Actions in the Blood.

The Aromatic Oils of Cloves and its allies enter the blood as such, and whilst oxydised in part by the red corpuscles leave the circulation mainly unchanged. Some of them are known to **increase the number of white corpuscles** by the dilatation of the abdominal vessels just described, and consequent stimulation of the organs which supply the blood with leucocytes.

3. Specific Actions and Uses.

The Aromatic Oils are rarely given in sufficient doses to produce definite specific effects on the tissues and organs. It may safely be assumed that in the main their action closely resembles that of Turpentine, or that of Camphor, respectively, according as the elæoptene or the stearoptene is in excess in the particular drug. (*See* pages 378 and 402.) Speaking generally, they are **stimulant and antispasmodic**; but let it be noted that a great part of this effect is reflex from the stomach, as has just been described.

4. Remote Local Actions and Uses.

The Aromatic Oils are excreted by the kidneys, skin, bronchi, liver, and probably the bowels; partly unchanged, partly as resins. In passing through these structures they **stimulate and disinfect** them. This subject is of the first importance in pharmacology, and will be best discussed under the head of Turpentine, an oil which produces very marked remote effects. See *Terebinthinæ Oleum*, page 399.

Pimenta.—PIMENTO. Allspice. The dried full-grown unripe fruit of Pimenta officinalis.

Characters.—Dark reddish-brown, nearly globular, two-celled fruits, from $\frac{1}{5}$ to $\frac{1}{3}$ inch in diameter. Pericarp rough externally, brittle and crowned by the remains of the four-toothed calyx in the form of a raised ring, surrounding the remains of the style. Each cell contains a single brownish-black reniform seed. Odour and taste warm and aromatic, resembling those of cloves. *Substances resembling Pimento:* Pepper, which has no calyx; Cubebs, which is stalked.

Composition.—Pimento contains chiefly the official *volatile oil*, chemically identical with oil of cloves.

Preparation.

Aqua Pimentæ.—Prepared by distillation.

From Pimento is made:

Oleum Pimentæ.—The oil distilled from Pimento.

Characters.—Yellow or yellowish-red, becoming darker. Odour and taste of Pimento. Sp. gr. not below 1·040. *Dose*, $\frac{1}{2}$ to 3 min.

ACTIONS AND USES.

The actions and uses of Pimento are similar to those of the preparations of Cloves and other **aromatics.**

Oleum Cajuputi.—OIL OF CAJUPUT. The oil distilled from the leaves of Melaleuca Leucodendron (Melaleuca Cajuputi).

Characters. — Bluish-green; odour strong, agreeable, camphoraceous; taste bitterish, aromatic, camphoraceous. Sp. gr. ·922 to ·930.

Composition.—Oil of Cajuput consists of *cajuputene hydrate* ($\frac{2}{3}$), isomeric with Borneo Camphor, $C_{10}H_{16},H_2O$, and a second oil, *cineol* ($\frac{1}{3}$), boiling at a higher temperature. *Impurities.*—Copper; detected by usual tests. Other volatile oils. *Dose*, $\frac{1}{2}$ to 3 min.

Preparation.

Spiritus Cajuputi.—1 in 10 of Alcohol 90 per cent. *Dose*, 5 to 20 min.

Oil of Cajuput is also contained in **Linimentum Crotonis.**

ACTIONS AND USES.

Cajuput Oil resembles in its actions and uses Oil of Cloves. It is used externally as a **stimulant and counter-irritant.**

Oleum Eucalypti.—Oil of Eucalyptus. The oil distilled from the fresh leaves of Eucalyptus Globulus, and other species of Eucalyptus.

Characters.—Colourless or pale yellow, becoming darker and thicker by exposure. Odour aromatic, camphoraceous; taste spicy, pungent, leaving a sensation of coldness in the mouth. Neutral. Sp. gr. ·910 to ·930. Readily soluble in alcohol.

Composition.—Oil of Eucalyptus consists of 70 per cent. of a terpene $C_{10}H_{16}$, with *cymene* $C_{10}H_{14}$, and an oxydised portion; also of an oil isomeric with cajuputene hydrate (*cineol*). It readily changes into a resin, yielding ozone. *Dose*, $\frac{1}{2}$ to 3 min.

Preparation.

Unguentum Eucalypti.—1 in 10 with Hard Paraffin and Soft Paraffin, white.

Eucalypti Gummi.—Eucalyptus Gum. A ruby-coloured exudation, or so-called red gum, from the bark of Eucalyptus rostrata, and some other species of Eucalyptus. From Australia.

Characters.—In grains or small masses. Thin fragments are transparent, ruby-red or garnet-red. It is somewhat tough, and has a very astringent taste. When chewed it adheres to the teeth and tinges the saliva red. *Solubility.*—80 or 90 per cent. is soluble in cold water; solution neutral; almost entirely soluble in alcohol 90 per cent.

Composition.—Eucalyptus Gum, contains *kino-tannic acia* (page 271), *catechin* (page 321), and *pyrocatechin. Impurity.*—Australian Kino, which is very resinous, and little soluble in water. *Dose*, 2 to 5 gr.

Preparation.

Trochiscus Eucalypti Gummi.—1 gr., with Fruit Basis.

ACTIONS AND USES.

Externally.—Oil of Eucalyptus is a powerful **antiseptic and disinfectant.**

Internally.—The action of Eucalyptus Oil is very similar to that of Oil of Turpentine, with which it is otherwise so closely allied. It is **antipyretic and antiperiodic** to a degree, like Quinine, and has been given in ague, typhoid fever, septicæmia and pneumonia.

Eucalyptus leaves the system by the kidneys and lungs, giving its odour to their excretions, and disinfecting these and the mucous surfaces. Its use is indicated in pyelitis, cystitis, bronchitis, dilated bronchi and asthma.

Red Gum is an **astringent,** used in diarrhœa.

Granati Cortex.—POMEGRANATE BARK. The dried bark of the stem and root of the Punica Granatum.

Characters.—Irregular, curved or channelled pieces, 2 to 4 inches long, ½ to 1 inch wide, externally rough, yellowish-grey, with conchoidal depressions; the *stem* bark is smoother, with minute lichens; internally yellow or yellowish-brown; fracture short, pale. No odour; taste astringent, feebly bitter.

Composition.—Pomegranate Root Bark contains *punico-tannic acid;* a colourless oily volatile alkaloidal body *pelletierine,* and other alkaloids; also a substance resembling mannite, mucilage, etc. *Incompatibles:* Alkalis, lime water, metallic salts, gelatin.

Preparation.

Decoctum Granati Corticis.—1 in 5. *Dose,* ½ to 2 fl.oz.

ACTIONS AND USES.

Pomegranate Root Bark has an **anthelmintic** and slightly irritant action, but is somewhat **astringent** unless taken freely. It is used in the treatment of tapeworm, which is expelled (not actually killed) by the Decoction, or by sulphate of pelletierine (5 to 8 gr.), preceded and followed by a purgative.

DIPTEROBIXINEÆ.

Oleum Gynocardiæ.—CHAULMOOGRA OIL (*Official in the Colonial and Indian Addendum*). The oil expressed from the seeds of Gynocardia odorata.

Characters.—A pale-brownish unctuous solid, with a disagreeable odour and taste.

Composition.—Chaulmoogra Oil contains a quantity of *palmitic acid*, with three other fatty acids, including *gynocardic acid* (*dose*, ½ to 3 gr.), the supposed active principle. *Dose*, 5 to 60 min. in milk, as emulsion or in capsules, after meals.

ACTIONS AND USES.

Chaulmoogra Oil is believed to be **a local stimulant and nutritive**, when administered either by inunction or internally. It was for a time much praised in leprosy, and has also been used for phthisis, lupus, psoriasis and chronic rheumatism.

CUCURBITACEÆ.

Colocynthidis Pulpa.—COLOCYNTH PULP. The dried pulp of the fruit of Citrullus Colocynthis freed from seeds.

Characters.—Peeled, in broken whitish balls, about 2 inches in diameter, consisting of pulp with embedded seeds. Broken-up pulp, alone official, is light, spongy, whitish, odourless, intensely bitter. *Impurities.*—Seeds and cortex, ground up with the pulp; starch.

Composition.—The active principles of Colocynth are a bitter glucoside *colocynthin*, $C_{56}H_{84}O_{23}$, usually amorphous, but crystallisable, readily soluble in water and alcohol; and *citrullin*, a resinoid powder, insoluble in water.

Preparations.

1. **Extractum Colocynthidis Compositum.**—Colocynth Pulp, 6; Extract of Barbados Aloes, 12; Scammony Resin, 4; Curd Soap, 4; Cardamom Seeds, 1; Alcohol, 60 per cent., 160. *Dose*, 2 to 8 gr.

2. **Pilula Colocynthidis Composita.**—Colocynth Pulp, 1; Barbados Aloes, 2; Scammony Resin, 2; Potassium Sulphate, ·25; Oil of Cloves, ·25; Water, *q.s.* (about ·25). *Dose*, 4 to 8 gr.

From Pilula Colocynthidis Composita is made:

PILULA COLOCYNTHIDIS ET HYOSCYAMI.—2; Green Extract of Hyoscyamus, 1. *Dose*, 4 to 8 gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Colocynth is a powerful **gastro-intestinal stimulant** or irritant, according to the amount given, causing speedy large and watery evacuations of the bowels, attended with griping and general depression unless its effect be covered by a carminative. It is one of the most powerful of official purgatives, acting as a **hydragogue cathartic**, as well as on the muscular coat and intestinal glands and liver, the secretions of which are rendered abundant and watery.

Colocynth is always used in combination with milder purgatives and carminatives. The Compound Pill is extensively employed alone, or with Calomel or Blue Pill, as an occasional purgative, to produce free evacuation of the bowels and relieve the portal system after free living, in bilious derangement, or in chronic constipation. It is less suitable as a habitual purgative. Its hydragogue effect is employed in cerebral congestion, where rapid "derivation" is required; and in dropsies, especially ascites, either alone or as the basis of a pill containing Elaterin. Colocynth must be given with caution in pregnancy, and entirely avoided in delicate or irritable conditions of the stomach and bowels.

2. ACTIONS IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

Colocynthin enters the blood, and is excreted partly by the kidneys, being, according to some, a diuretic.

Elaterium.—A sediment from the juice of the fruit of Ecballium Elaterium.

Characters.—In flattened or slightly curved opaque cakes, about $\frac{1}{10}$ inch thick; pale green, greyish-green, or yellowish-grey; fracture finely granular; odour faint, tea-like; taste bitter and acrid (but not to be tasted by the student). *Impurities.*—Starch, flour and chalk.

Composition.—Elaterium contains 25 per cent. and not less than 20 per cent. of the official active principle, *elaterin*. *Dose*, $\frac{1}{10}$ to $\frac{1}{2}$ gr.

From Elaterium is made:

Elaterinum.—Elaterin, $C_{20}H_{28}O_5$. The active principle of Elaterium.

Characters.—Small hexagonal scales; taste bitter. *Solubility.*—Nearly insoluble in water, sparingly soluble in alcohol 90 per cent.; readily in chloroform. Neutral to litmus. With melted phenol it yields a solution which, with H_2SO_4, becomes first crimson and then rapidly scarlet. *Impurities.*—Alkaloids. *Dose*, $\frac{1}{40}$ to $\frac{1}{10}$ gr.

Preparation.

Pulvis Elaterini Compositus.—1 to 39 of Milk Sugar. 1 in 40. *Dose*, 1 to 4 gr.

ACTIONS AND USES.

Elaterin acts much like Colocynth, as a **gastro-intestinal irritant**, but is decidedly more violent, being the most powerful hydragogue purgative which we possess. It produces, even in doses of $\frac{1}{40}$ to $\frac{1}{10}$ gr., numerous very watery motions, with griping and considerable depression.

Elaterin is used almost entirely as a **hydragogue purgative** in dropsies and uræmia, relieving the venous pressure by free evacuation of fluid into the bowel. More rarely it is given as a rapid "derivative" in cerebral cases; and still more rarely as an evacuant in obstinate constipation. This drug must be used with caution, and must not be ordered in catarrhal states of the stomach or bowels.

UMBELLIFERÆ.

Conii Folia.—Hemlock Leaves. The fresh leaves and young branches of Conium maculatum; collected when the fruit begins to form.

Characters.—Leaves pinnately divided; the lower decompound, and sometimes 2 feet long; glabrous; arising from a smooth stem marked with *dark purple spots*, by clasping petioles, those of the lower leaves hollow. Odour strong and disagreeable, mouse-like, especially when rubbed with solution of potassium hydroxide.

Conii Fructus.—Hemlock Fruit. The dried, full-grown, unripe fruits of Conium maculatum.

Characters.—Broadly ovoid, greenish-grey; about $\frac{1}{8}$ inch long, and nearly as broad, somewhat laterally compressed, crowned by the depressed stylopod. Mericarps usually

separated; each glabrous, possessing five irregular, crenate, primary ridges; the endosperm deeply grooved on the commissural surface; in the transverse section of the mericarp no vittæ are visible. No marked odour or taste, but when rubbed with solution of potassium hydroxide a strong and disagreeable odour is produced resembling the odour of mice.

Substances resembling Conium Fruit: Caraway, Anise, Dill; known by presence of vittæ.

Composition.—The active principle of Conium is a yellowish liquid alkaloid, *conine*, $C_8H_{16}HN$. It is strongly alkaline, oily, and volatile; with a peculiar disagreeable mouse-like odour; nearly insoluble in water. It is readily disengaged from the preparations of the plant by the addition of alkalis; and is liable both to conversion into an inert resinous mass by exposure, and to decomposition by heat. The preparations of Conium, for these and probably other reasons, are peculiarly uncertain in strength and action. *Coniic Acid*, *methylconine*, $C_8H_{14}CH_3N$, a colourless fluid, and *conhydrine*, $C_8H_{17}NO$, crystalline, also exist in Hemlock. *Incompatibles.*—Caustic alkalis, vegetable acids, and astringents.

Preparations.

A. *Of Conii Folia:*

Succus Conii.—3 of the expressed juice, with 1 of Alcohol 90 per cent. *Dose*, 1 to 2 fl.dr.

From Succus Conii is prepared:

UNGUENTUM CONII.—Juice, 88, evaporated to 11; Hydrous Wool Fat, 33.

B. *Of Conii Fructus:*

Tinctura Conii.—1 in 5 of Alcohol 70 per cent.; by percolation. *Dose*, 30 to 60 min.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally Conium has been used as an **anæsthetic**, to relieve the pain of cancer. Experiment fails to confirm this action, the whole of the sensory nervous system remaining unaffected by the drug, unless it be indirectly by poisonous doses.

Internally.—**Conium may in some cases cause irritation and vomiting.**

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS AND USES, AND REMOTE LOCAL ACTIONS.

Conine is readily absorbed into the blood; reaches the tissues; and is found unchanged in many of the organs after administration. Moderate doses cause a sense of weight in the legs and weakness of the knees; confusion of vision, with drooping of the upper lids, and swollen appearance of the eyes; giddiness; thickness of speech, and slight dysphagia. The poisonous effects of the plant are well described in the classical account of the death of Socrates.

On analysis, the action of Conium is found to be as follows: The **motor nerves are** the parts specially attacked by Conium, being **paralysed from their extremities upwards,** whence the heaviness and weakness of the limbs. The muscles themselves remain irritable. The motor parts of the cord are only slightly affected, but their reflex excitability is moderately reduced. The **respiratory centre** in the medulla is finally **paralysed**; the cardiac and vascular centres are not definitely influenced. The convolutions remain intact until asphyxia supervenes. The corpora striata are possibly depressed. Death in Hemlock poisoning occurs by asphyxia, due to paralysis of the respiratory nerves and depression of the respiratory centre.

Conium, although of great interest to the pharmacologist, is but little used in medicine. It has been recommended, as large doses of the Succus, in spasmodic and convulsive diseases such as tetanus, chorea and epilepsy; in mania with muscular excitement; and in asthma, pertussis and spasmodic affections of the larynx. Conine is excreted unchanged, chiefly in the urine.

Asafetida.—ASAFETIDA. A gum-resin obtained by incision from the root of Ferula fœtida, and probably other species.

Characters.—In rounded or flattened tears from $\frac{1}{2}$ to 1 inch in diameter, or in masses of agglutinated tears, dull yellow in colour, darkening on keeping. When fresh the tears are tough at ordinary temperatures, but they become hard in cold weather. Internally they are yellowish and translucent, or milky white and opaque, the freshly exposed surfaces gradually assuming a pink colour which changes to red and finally to reddish-brown. It should contain not less than 50 per cent. of matter soluble in alcohol 90 per cent., and should yield not more than 10 per cent. of ash when

incinerated. Taste bitter, acrid, alliaceous; odour strong, alliaceous, persistent. Triturated with water it forms a white emulsion. The freshly fractured surface of a tear, touched with equal parts of nitric acid and water, assumes briefly a fine green colour. *Substances resembling Asafetida:* Galbanum, Ammoniacum, Benzoin; known by odour.

Composition.—Asafetida contains 5 per cent. of a *volatile oil*, 65 per cent. of *resin*, and 25 per cent. of *gum*. The oil is probably complex, but consists chiefly of allyl sulphide $(C_3H_5)_2S$, essential oil of garlic, to which the unpleasant odour is due. The resin also contains sulphur. *Impurities.*—Earthy matter, detected by burning. *Dose*, 5 to 15 gr.

Preparations.

1. **Pilula Aloes et Asafetida.**—Equal parts of Socotrine Aloes, Asafetida, Hard Soap, and Confection of Roses. *Dose*, 4 to 8 gr.

2. **Spiritus Ammoniæ Fetidus.**—Asafetida, 1·5; Strong Solution of Ammonia, 2; Alcohol 90 per cent., to make 20. *Dose*, 20 to 40 min. repeated; 60 to 90 min. at once.

3. **Tinctura Asafetidæ.**—1 in 5 of Alcohol, 70 per cent.; by maceration. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

Asafetida is also contained in Pilula Galbani Composita; 2 in 7.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Asafetida **possesses the actions of other volatile oils and resins** upon the alimentary canal, but differs from them in this highly important respect, that whilst most of them are aromatic and pleasant to the palate, it is **extremely disagreeable**. The mental influence of this nauseous impression, added to the other stimulant effects on the mouth and stomach (see *Caryophyllum*, p. 292), constitutes Asafetida a powerful **nervine stimulant**, which arrests the emotional disturbance, muscular spasms and other morbid nervous disorders of hysteria. The **stimulant action** of volatile oils **on the bowel** (see *Terebinthinæ Oleum*, p. 401) is specially marked; and an enema of Asafetida may be employed to expel flatulence, relieve constipation and arrest convulsions.

2. ACTIONS IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS AND USES.

The volatile oil of Asafetida passes through the blood and

tissues, and is excreted in the urine, sweat, breath and discharge from wounds. Thus remotely it exerts the usual stimulant action of volatile oils, and is sometimes given as a **stimulant and disinfectant expectorant** in chronic bronchitis.

Galbanum.—GALBANUM. A gum-resin obtained from Ferula galbaniflua, and probably from other species.

Characters.—In tears, or in masses of agglutinated tears. *Tears* round or irregular, from the size of a lentil to a hazel nut, generally that of a pea; yellowish- or orange-brown externally, often rough and dirty on the surface, usually opaque and yellowish-white internally, sometimes translucent, bluish-green and mixed with transverse slices of the root, hard and brittle in cold weather, softening in the summer, and by the heat of the hand becoming ductile and sticky. The *masses* irregular, and variable in colour from yellowish-brown to bluish-green. Odour characteristic; taste bitter, unpleasant. *Substances resembling Galbanum:* Ammoniacum, Asafetida, Benzoin; known by odour.

Composition.—Galbanum contains 3 to 6 per cent. of a *volatile oil*, isomeric with turpentine, $C_{10}H_{16}$; 20 per cent. of *gum;* and 65 per cent. of *resins*, which yield by dry distillation a blue oil, and *umbelliferone*, $C_9H_6O_3$, in colourless, odourless needles. *Dose*, 5 to 15 gr.

Preparation.

Pilula Galbani Composita.—Compound Pill of Galbanum. Compound Pill of Asafetida. Asafetida, 2; Galbanum, 2; Myrrh, 2; Syrup of Glucose, 1. *Dose*, 4 to 8 gr.

ACTIONS AND USES.

Galbanum acts and is used much like **Asafetida** and Ammoniacum, and is always given in combination with either of these substances.

Ammoniacum.—AMMONIACUM. A gum-resin exuded from the flowering and fruiting stem of Dorema Ammoniacum, and probably other species.

Characters.—In small dull pale yellowish or brownish

tears, or in nodular masses varying in size from ¼ to 1 inch in diameter; hard and brittle when cold, the freshly fractured surface having a waxy lustre; it softens when warmed. Internally opaque, varying from milky white to pale brownish-yellow. Odour faint, characteristic, but not alliaceous; taste bitter, acrid. Triturated with water it forms a white emulsion. The freshly fractured surface is coloured yellow by solution of potassium hydroxide, dark red or orange by solution of chlorinated soda. If a small fragment be heated to redness in a dry test-tube, the contents of the tube, after cooling, yield with boiling water a solution which when largely diluted with water and made alkaline with solution of ammonia does not exhibit a blue fluorescence (distinction from asafetida and galbanum). *Substances resembling Ammoniacum:* Asafetida, Galbanum, Benzoin; known by odour and above test.

Composition.—Ammoniacum contains about 4 per cent. of a *volatile oil*, 20 per cent. of gum, and 70 per cent. of *resin*, $C_{40}H_{50}O_9$. The oil does not contain sulphur. *Dose*, 5 to 15 gr.

Preparations.

1. **Emplastrum Ammoniaci cum Hydrargyro.**—328; Mercury, 82; Olive Oil, 3·5; Sublimed Sulphur, ·50.

2. **Mistura Ammoniaci.**—A milk-like emulsion. 5 triturated in 150 of Water, with the addition of 10 of Syrup of Tolu; and straining. *Dose*, ½ to 1 fl.oz.

Ammoniacum is also an ingredient of Pilula Ipecacuanhæ cum Scilla, 1 in 6; and of Pilula Scillæ Composita, 4 in 21.

ACTIONS AND USES.

The actions of Ammoniacum closely resemble those of the other aromatics and oleo-resins, but this drug is used almost solely for its remote local effects. Being excreted by the bronchial mucosa, it stimulates the surface and disinfects the secretions of the part (see *Terebinthinæ Oleum*, p. 403); and it probably acts similarly on the skin. It is used as a **disinfectant expectorant** in chronic bronchitis with profuse discharge, and as a constituent of plasters intended to strengthen the circulation in the skin and promote absorption.

Anisi Fructus.—ANISE FRUIT. The dried ripe fruit of Pimpinella Anisum.

Characters.—Ovoid in form, somewhat laterally compressed, rough from the presence of short, bristly hairs, greyish-brown, about $\frac{1}{8}$ inch long and $\frac{1}{12}$ inch broad. Mericarps usually remain united and attached to the pedicel. The primary ridges pale, slender, entire. Each mericarp exhibits in transverse section numerous vittæ. Odour agreeably aromatic; taste aromatic and sweet.

Composition.—The chief constituent is the official ***oil.***

Preparation.

Aqua Anisi.—10 from 1, by distillation.

From Anisi Fructus is made:

Oleum Anisi.—Oil of Anise. The oil distilled from Anise Fruit; or from the fruit of the Star-Anise, Illicium verum (N.O. *Magnoliaceæ*, page 219).

Characters.—Colourless or pale yellow; with the odour of the fruit, and a mildly aromatic taste. Congeals between 50° and 59° F., and should not again become liquid below 59°. Lævo-gyrate. Sp. gr. ·975 to ·990 at 68° F.

Composition.—Oil of Anise is composed of two bodies, a terpene ($\frac{1}{5}$), and a stearoptene *anethol* ($\frac{4}{5}$), $C_{10}H_{12}O$, crystallising out at the above temperatures. *Dose*, $\frac{1}{2}$ to 3 min.

Preparation.

Spiritus Anisi.—1 to 9 of Alcohol 90 per cent. *Dose*, 5 to 20 min.

Oil of Anise is also contained in Tinctura Camphoræ Composita and Tinctura Opii Ammoniata.

ACTIONS AND USES.

The actions and uses of Anise are those of the **aromatic** oils in general. It is believed, however, to possess a specially stimulant action on the bronchial mucosa, like Ammoniacum, probably because excreted in part by it. It is therefore a favourite flavouring agent for cough mixtures and lozenges.

Coriandri Fructus.—Coriander Fruit. The dried ripe fruit of Coriandrum sativum.

Characters.—Nearly globular, about $\frac{1}{5}$ inch in diameter, uniform brownish-yellow, glabrous. The two mericarps closely united, crowned by the calyx teeth and stylopod. Primary ridges wavy, inconspicuous; secondary ridges straight, more prominent. The transverse section exhibits two vittæ on the commissural surface of each mericarp. Odour aromatic. Taste agreeable, especially when bruised.

Composition.—The principal constituents of Coriander are *aromatic oils*, one of which is official.

From Coriandri Fructus is made:

Oleum Coriandri.—The oil distilled from Coriander Fruit.

Characters.—Pale yellow or colourless, having the odour and flavour of the fruit and a mild aromatic taste. Sp. gr. ·870 to ·885. *Impurities.*—Oil of turpentine and added terpenes.

Composition.—Like that of hydrated oil of turpentine, $C_{10}H_{16},H_2O$, isomeric with Borneo camphor (see *Camphora*, p. 376). *Dose*, $\frac{1}{2}$ to 3 min.

Coriander Fruit is contained in Confectio Sennæ, Syrupus Rhei, Tinctura Rhei Composita, Tinctura Sennæ Composita; *the Oil in* Syrupus Sennæ.

ACTIONS AND USES.

The actions and uses of Coriander do not differ from those of other **aromatic** substances. Its flavour specially covers the tastes of Senna and Rhubarb.

Fœniculi Fructus.—FENNEL FRUIT. The dried fruit of Fœniculum capillaceum, collected from cultivated plants.

Characters.—From $\frac{1}{5}$ to $\frac{2}{5}$ inch long, and about $\frac{1}{10}$ inch broad, oblong, curved, capped by a conspicuous stylopod and two styles; smooth, greenish-brown or pale yellowish-brown. Odour aromatic; taste aromatic, sweet and agreeable. The fruit is readily separated into its two mericarps, each with 5 prominent primary ridges, and exhibiting in transverse section 6 large vittæ. *Substances resembling Fennel:* Conium, Caraway, Anise. Fennel is larger than Conium, and has prominent vittæ.

Composition.—Fennel contains a *volatile oil*, apparently

identical with Oil of Anise (*see* p. 305). It is light yellow, with the peculiar odour of the fruit.

Preparation.

Aqua Fœniculi.—10 from 1, by distillation.

Fennel is also contained in Pulvis Glycyrrhizæ Compositus.

ACTIONS AND USES.

Fennel has the same actions, and is used for the same purposes, as other **aromatic** substances.

Carui Fructus.—Caraway Fruit. The dried fruit of Carum Carvi.

Characters.—Mericarps usually separate; each from $\frac{1}{6}$ to $\frac{1}{4}$ inch long and about $\frac{1}{25}$ inch broad; brown with paler primary ridges; slightly curved, tapering towards each end; glabrous. Odour aromatic; taste agreeable, aromatic. *Substances resembling Caraway:* Conium, Fennel. Caraway has small ridges and a spicy taste.

Composition.—The official *volatile oil of caraway* is the active constituent of the fruit.

Preparation.

Aqua Carui.—10 from 1, by distillation.

From Carui Fructus is made:

Oleum Carui.—The oil distilled from Caraway Fruit.

Characters.—Colourless or pale yellow, with the characteristic odour and spicy taste. Sp. gr. ·910 to ·920. *Composition.*—Is a mixture of *caruen*, $C_{15}H_{24}$, a terpene, and *caruol*, $C_{10}H_{14}O$, isomeric with thymol. *Dose*, $\frac{1}{2}$ to 3 min.

Caraway Fruit is contained in Pulvis Opii Compositus, Confectio Piperis, Tinctura Cardamomi Composita, and Tinctura Sennæ Composita; *Oleum Carui in* Pilula Aloes Barbadensis.

ACTIONS AND USES.

Caraway acts like other **aromatic** substances. It is extensively used as a flavouring and carminative agent.

Anethi Fructus.—DILL FRUIT. The dried ripe fruit of Peucedanum graveolens.

Characters.—The two mericarps of which the fruit is composed are separate and freed from the pedicel; each of them broadly oval, about $\frac{1}{6}$ inch long, $\frac{1}{12}$ to $\frac{1}{8}$ inch broad; very strongly compressed dorsally; brown; the dorsal ridges inconspicuous, the lateral prolonged into paler brown wings. Odour and taste agreeably aromatic.

Substances resembling Dill.—Conium, Anise, Fennel, Caraway. Dill is winged.

Composition.—Dill contains the official *volatile oil.*

Preparation.

Aqua Anethi.—10 from 1, by distillation.

From Anethi Fructus is made:

Oleum Anethi.—The oil distilled from Dill Fruit.

Characters.—Pale yellow; odour that of the fruit; taste sweet and aromatic. Dextro-rotatory. Sp. gr. ·905 to ·920. *Composition.*—It contains a terpene *anethene*, $C_{10}H_{16}$, and an oxydised oil, $C_{10}H_{14}O$, identical with caruol. *Dose*, $\frac{1}{2}$ to 3 min.

ACTIONS AND USES.

The actions and uses of Dill are similar to those of other aromatic substances. It is given as a carminative to infants; and to cover the taste of Sodium salts.

Sumbul Radix.—SUMBUL ROOT. The dried transverse slices of the root of Ferula Sumbul.

Characters.—About 1 to 3 inches in diameter; $\frac{3}{4}$ to more than 1 inch thick. Covered externally with a dusky-brown papery transversely wrinkled cork, with short bristly fibres; internally spongy, coarsely fibrous, dry, dirty yellowish-brown, mottled with whitish patches and spots of exuded resin. Odour strong, *musk-like;* taste bitter, aromatic.

Composition.—Sumbul contains a small quantity of a *volatile oil;* 9 per cent. of a soft *resin*, with its characteristic odour; *valerianic acid;* and a crystalline substance, *sumbulic acid.*

Preparation.

Tinctura Sumbul.—1 in 10 of Alcohol 70 per cent.; by maceration. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

Sumbul is a stimulant, like the **aromatic** oils in general, and specially resembles Valerian and Musk. It is used in the same class of cases as these drugs. *See* pages 325 and 427.

CAPRIFOLIACEÆ

Sambuci Flores.—Elder Flowers. The flowers of Sambucus nigra, separated from the stalks; and either fresh, or preserved while fresh with common salt.

Characters.—Flowers small; calyx superior, 5-toothed; corolla flat, rotate, 5-lobed, creamy-white, with 5 stamens inserted in the tube; anthers yellow. Odour sweet, faint, not altogether agreeable; taste slightly bitter.

Composition.—Elder Flowers contain a trace of a *volatile oil*, a *resin*, and *valerianic acid*, $C_5H_{10}O_2$.

Preparation.

Aqua Sambuci.—1 from 1, by distillation.

ACTIONS AND USES.

Elder Flowers are chiefly used for **flavouring** purposes, but probably possess mildly diaphoretic and diuretic properties.

RUBIACEÆ.

Cinchonæ Rubræ Cortex.—Red Cinchona Bark. "Bark." The dried bark of the stem and branches of *cultivated* plants of Cinchona succiruba.

Characters.—Quills or incurved pieces, coated with periderm; from 2 inches to a foot or more in length; the bark itself $\frac{1}{10}$ to $\frac{1}{4}$ inch thick, rarely more; outer surface reddish-brown; rough from longitudinal furrows and ridges, or transverse cracks and warts; inner surface brick-red,

irregularly and coarsely striated. Fracture fibrous. Powder brownish or reddish-brown. No marked odour; taste bitter, somewhat astringent.

(Salts of Quinine may also be obtained from various species of Cinchona and Remijia.)

Composition.—Cinchona Barks contain (1) four important *alkaloids*, namely: *quinine*, *cinchonine*, *quinidine*, and *cinchonidine*; (2) two *peculiar acids*, *kinic* and *kinovic* acids; (3) a variety of tannic acid called *cincho-tannic acid*; (4) *cinchona red*; and (5) traces of an aromatic *volatile oil*. Remijia bark also yields an alkaloid, *cupreine*.

(1) **The alkaloids of cinchona.**—*a. Quinine*, $C_{20}H_{24}N_2O_2$, occurs (as the hydrate) in white acicular crystals, inodorous, very bitter. It reacts like an alkali, forming neutral and acid salts with acids; is fluorescent in dilute solutions of the Sulphate; turns the plane of polarisation to the left; and yields in solution a green colour when treated with Cl water and then with NH_4HO. An *amorphous* form of Quinine is obtained after crystallisation of the Sulphate from the mother liquor, or from *quinoidine*, which appears to be a compound of this alkaloid and others with resin and colouring matters.

b. Cinchonine, $C_{20}H_{24}N_2O$, consists of colourless prisms, inodorous, and bitter; forms salts with acids; but possesses no fluorescence in solution; is dextrogyrate, and gives no green colour with Cl water and NH_4HO.

c. Quinoidine, $C_{20}H_{24}N_2O_2$, *i.e.* isomeric with Quinine, closely resembles it, but crystallises in prisms, and is dextrogyrate.

d. Cinchonidine, $C_{29}H_{24}N_2O$, *i.e.* isomeric with Cinchonine, resembles that alkaloid, but yields indistinctly fluorescent solutions, and left-handed polarisation.

Red Cinchona Bark ought to yield 5 to 6 per cent. of alkaloids, not less than a half being Quinine and Cinchonidine. Of the other species of Cinchona, Yellow Bark should yield 2·5 to 3·8 per cent. of Quinine; and Pale Bark, 0·7 to 1·4 per cent. of alkaloids, chiefly Cinchonine or Quinidine with a little Quinine.

(2) (3) **The acids of cinchona.**—*a. Kinic* or *quinic* acid, $C_7H_{12}O_6$, occurs in large colourless prisms, soluble in water. In the bark it is probably combined with the alkaloids; and it is found also in the Coffee-bean, the Vaccinium myrtillus and other plants. It is closely allied to benzoic acid, and appears in the urine as hippuric acid.

b. Kinovic acid, $C_{24}H_{38}O_3$, "kinova bitter," is a white amorphous body, insoluble in water. It appears to be a product with glucose, of *kinovin*, a glucoside, $C_{30}H_{48}O_8$.

c. Cincho-tannic acid, the astringent principle and soluble red-colouring matter of the bark, amounts to 1 to 3 per cent. It is a yellow hygroscopic body, and differs from ordinary tannic acid in striking green with persalts of iron, and in being very readily oxydised, one of the products being:

(4) **Cinchona red**, a reddish-brown substance, without taste or odour, nearly insoluble in water.

(5) **The volatile oil**, obtained by distillation, has the odour of the bark.

Impurities.—Inferior barks are detected by the absence of the true characters of the official barks, and by a quantitative test for (I.) Quinine and Cinchonidine, and (II.) the total alkaloids, as follows: I. *For Quinine and Cinchonine:* This consists in (1) mixing 20 grammes of red cinchona bark with 6 grammes of calcium hydroxide, and moistening with water; (2) boiling and percolating with benzolated amylic alcohol, to exhaust the bark; (3) shaking the filtrate with HCl and water, to separate the alkaloids as hydrochlorides; (4) neutralising with ammonia and concentrating; and (5) adding a solution of 1·5 gramme of tartarated soda, to separate the insoluble tartrates of quinine and cinchonidine, $\frac{8}{10}$ of which will consist of quinine and cinchonidine. Five times this weight gives the percentage of these alkaloids.

II. *For total alkaloids.*—This consists in precipitating the other alkaloids by adding ammonia in excess to the mother liquor of I. Five times the weight of these, added to the percentage weight of quinine and cinchonidine, gives the percentage of total alkaloids.

Incompatibles.—Ammonia, lime water, metallic salts and gelatin. May be combined with mineral acids.

Preparations.

A. *From Cinchonæ Rubræ Cortex are prepared:*

1. **Extractum Cinchonæ Liquidum.**—Made by extracting with Hydrochloric Acid, Glycerin, and Water; evaporating to a definite strength; and adding Alcohol, 90 per cent., and Water. *Standardised* to contain 5 per cent. of alkaloids. *Dose*, 5 to 15 min.

2. **Infusum Cinchonæ Acidum.**—1 in 20 of boiling Water, with ·25 of Aromatic Sulphuric Acid. *Dose*, ½ to 1 fl.oz.

3. **Tinctura Cinchonæ.**—1 in 5 of Alcohol, 70 per cent.; by percolation. *Standardised* to contain 1 per cent. of total alkaloids. *Dose*, ½ to 1 fl.dr.

From Tinctura Cinchonæ is prepared:

TINCTURA CINCHONÆ COMPOSITA.—Tincture of Cinchona, 50; Bitter-Orange Peel, 5; Serpentary Rhizome, 2·5; Saffron, ·63; Cochineal, ·32; Alcohol, 70 per cent., to make 100. By maceration. *Standardised* to contain ·5 per cent. of total alkaloids. *Dose*, ½ to 1 fl.dr.

B. *From the Cortex of various species of Cinchona and Remijia are made:*

1. **Quininæ Sulphas.**—Quinine Sulphate $[(C_{20}H_{24}N_2O_2)_2, H_2SO_4]_2 15H_2O$.

Source.—Obtained from the bark of various species of Cinchona and Remijia.

Characters and tests. — Filiform, silky, white crystals, of an intensely bitter taste. *Solubility.*—1 in about 800 of water, imparting to it a fluorescent tint; entirely soluble in water acidulated with a mineral acid. Solution of Ammonia gives with solutions a white precipitate of quinine, soluble in excess and in ether. In mixtures, 1 min. of a diluted mineral acid will dissolve one grain.

Impurities.—Lime, chalk, magnesia, starch, and other white powders. Should not yield more than 3 per cent. of impure cinchonidine. Should not respond to tests for cinchonine, cupreine, quinidine, or amorphous alkaloid. *Incompatibles.*—Alkalis and their carbonates, astringent infusions. *Dose*, 1 to 3 gr., as a tonic; 5 to 20 gr., as an antipyretic and antiperiodic. *See* page 317.

Preparations.

a. **Ferri et Quininæ Citras.**—16 in 100. *See* page 84. *Dose*, 5 to 10 gr.

b. **Pilula Quininæ Sulphatis.**—30; Tartaric Acid, 1; Tragacanth, 1; Glycerin, 4. *Dose*, 2 to 8 gr.

c. **Tinctura Quininæ Ammoniata.**—2; Solution of Ammonia, 10; Alcohol, 60 per cent., 90; by solution. 1 in 51. *Dose*, ½ to 1 fl.dr.

Sulphate of Quinine is also contained in:

d. **Syrupus Ferri Phosphatis cum Quinina et Strychnina.**—$\frac{1}{6}$ gr. in 1 fl.dr. *See* page 85.

2. **Quininæ Hydrochloridum.**—Quinine Hydrochloride. $C_{20}H_{24}N_2O_2,HCl,2H_2O$.

Source.—Obtained from the bark of various species of Cinchona and Remijia.

Characters.—Crystals resembling those of Quinine Sulphate, but generally somewhat larger. *Solubility.*—1 in 35 of cold water; 1 in 3 of alcohol, 90 per cent.; very soluble in the boiling liquids. *Dose*, 1 to 10 gr.

Preparation.

a. **Tinctura Quininæ.**—1 in 50 of Tincture of Orange; by solution. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

b. **Vinum Quininæ.**—2; Orange Wine, 875. *Dose*, $\frac{1}{2}$ to 1 fl.oz.

3. **Quininæ Hydrochloridum Acidum.**—Acid Quinine Hydrochloride. $C_{20}H_{24}N_2O_2,2HCl,3H_2O$.

Source.—Obtained from the bark of various species of Cinchona and Remijia.

Characters.—A white crystalline powder. *Solubility.*—In less than its own weight of water, yielding a somewhat acid liquid. *Dose*, 1 to 10 gr.

ACTIONS AND USES.

The actions and uses of the Cinchona Barks will be described along with those of Quinine, their most important active principle.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Quinine arrests some kinds of fermentation and decomposition, and might therefore be used as a local **antiseptic and disinfectant** to wounds and ulcers, but for its cost. A solution of 2 gr. of the Sulphate to 1 fl.oz., applied as a spray to the nose, relieves hay asthma. A solution of 4 gr. to 1 fl.oz., with a minimum of Diluted Sulphuric Acid, is recommended as a constant application in diphtheritic conjunctivis, and to wash out a foul bladder.

Internally.—Quinine is freely absorbed by the mucous

membranes, and may be given either by the mouth, by the rectum as suppository, or subcutaneously. In the mouth, stomach and intestine it acts as a powerful **bitter**, possessing all the important influences on the secretions of the digestive tract described under *Calumba* (page 219). The **stomachic** effect of Quinine is obtained from small doses, ½ to 2 grains, and must be kept entirely distinct from the specific effects to be presently described, otherwise confusion as to the actions and value of this important drug will be the result. In small doses, like all other bitters, it improves the appetite and digestion, stimulates the heart and circulation, and increases the sense of comfort and *bien être* produced by a meal; and its continued use will thus increase the bodily strength, that is, will be **tonic** in its effects. Quinine is extensively used for this purpose, especially during convalescence, in debilitated subjects, and in patients taking depressing remedies such as mercury. Larger doses (10 to 30 gr. or more) have the opposite effect, interfering with digestion, and so causing depression.

In the stomach Quinine or its salts become the hydrochloride, a soluble and diffusible salt which readily enters the blood. Little or none escapes unabsorbed in the fæces.

2. ACTIONS IN THE BLOOD, AND USES.

Quinine or its hydrochloride may be found in the blood within a few minutes of its administration. Here the alkaloid produces several definite effects, namely: (1) It binds the oxygen more firmly to the hæmoglobin, so that oxygenation is less easy and less active. (2) It causes enlargement of the individual red corpuscles. (3) It paralyses the leucocytes, when given in large doses, thus checking diapedesis; and reduces the number of visible leucocytes very greatly (to one-fourth). In blood freshly drawn, it (4) retards the formation of acid (loss of oxygen and increase of carbonic acid) which naturally occurs in blood removed from the vessels; and (5) it reduces the ozonising power of blood, *e.g.* on guaiacum and turpentine. Altogether, Quinine manifestly **interferes with oxygenation**, the giving up of oxygen by the red corpuscles. The outcome of these effects will be presently considered. Given in malaria, Quinine quickly causes the plasmodium to disappear from the general circulation; but it seems to have no effect on the crescent bodies, nor to interfere with their evolution into the flagellated organisms. Thus malaria is remarkably benefited by Quinine, which is an **antiperiodic** or direct specific, whether given to persons

exposed to the morbid influence as a prophylactic measure, or to the subjects of ague. It acts best in fresh cases, the first dose of 10 gr. being given at any time in relation to the attack (excepting during the early stages of a paroxysm), and 5 gr. every five or six hours for the next two or three days. All forms of malarial fever are benefited by Quinine, as well as many diseases and disorders of malarial origin, such as neuralgia, hepatic disturbances, etc. The functions of the liver and bowels must be maintained during this treatment; and the Quinine may be combined with Morphine if its effects are not well marked. If there be any difficulty in administering the drug, it is to be given hypodermically or by the bowel. The Acid Hydrochloride in 10-gr. doses dissolved in sterilised water is the most suitable form for subcutaneous use.

3. SPECIFIC ACTIONS.

Quinine passes through the tissues without decomposition, quickly making its appearance in them, but not being completely excreted for several days, especially in fever. The maximum effect of large doses is produced in about five hours. If, therefore, the full specific effect be desired, a single large dose (15 to 30 gr.) must be given, and this may have to be repeated once or twice within the hour: small doses given over a length of time do not sufficiently accumulate.

The obvious phenomena produced by a full dose (15 to 30 gr.) of Quinine are not by any means its most important effects. It acts most strikingly upon the nervous centres, and causes confusion of the mental faculties, noises in the ears and deafness, disorders of vision, headache, giddiness, vomiting, and possibly prostration from involvement of the cord and circulation. Of infinitely greater interest and importance are certain concomitant effects of Quinine which require careful investigation for their discovery. These effects may be arranged as follows:—

(1) Quinine **lowers the body temperature**, very moderately in the healthy subject; very markedly in the pyrexia of many acute specific fevers. It appears to be difficult to lower the normal temperature by drugs, as compensating mechanisms are probably brought into play; but the rise of temperature and the perspiration normally produced by muscular exercise are prevented by Quinine. In malarial fevers, typhoid, acute pneumonia, and some forms of hectic and other periodic fevers, the defervescent effect of Quinine is unquestionable.

(2) Quinine appears to **reduce the amount of nitrogenous excretions,** *i.e.* urea and uric acid, and probably also of carbonic acid, as determined both in healthy and fevered animals, and in man.

These two sets of effects taken together point to a powerful action of Quinine in reducing the metabolism of the body, of which heat and the excretions are the two most measurable products. This conclusion is supported by other facts, observed out of the body, namely, that: (3) a solution of albumen cannot be converted into peptone in an atmosphere of ozone if Quinine be present. (4) Healthy pus and fresh vegetable juices lose their ozonising power if mixed with Quinine. (5) Phosphorescent infusoria (rapidly oxydating protoplasmic masses) lose their phosphorescence in the presence of Quinine. (6) Fungi absorb oxygen less readily, and many forms of fermentation are arrested, in the presence of Quinine. These facts indicate that Quinine so combines with living cellular protoplasm as to render it less able to incorporate oxygen, and more resistant of vital change (metabolism). We have already seen that the oxygen actually in the corpuscles is bound more firmly to them by Quinine. We may therefore conclude that the effect of Quinine in the body is to check metabolism by interfering with the oxydation of protoplasm generally, with oxygenation, and with the associated actions of ferments. Thus the fall of temperature produced by Quinine is due to diminished production of heat in the body, not to increased loss of heat; it is effected through the tissues, not through the cerebral thermogenetic centres, as far as is known; and the fever-causing processes themselves (probably allied to fermentations) are also controlled by the drug, which affects their organic causes, whether living organisms or complex chemical substances.

An action such as this upon the processes of nutrition, though it might escape the notice of an ignorant observer, is more "powerful" even than the action of Morphine upon a highly-sensitive nervous mechanism such as the convolutions.

Turning to the other systems, we find that whilst small doses of Quinine accelerate the heart and raise the pressure, as we saw when considering its action on the stomach, full doses diminish the force and frequency of systole, lengthen diastole, and lower the pressure; effects due to a direct action on the cardiac ganglia and muscle, and on the vessel walls and their centre. Respiration is accelerated by medium doses, depressed by large doses; and death, should it occur, is referable to respiratory and cardiac failure. The spleen is reduced in size, and hardened.

4. Specific Uses.

The uses of Quinine, which have been mainly established by experience, are in accord with these physiological results. Its specific actions may be employed in the following diseases, in addition to malaria :—

1. *Febrile conditions in general* are relieved by the **antipyretic** effect of Quinine, for instance, acute pneumonia, typhoid fever, puerperal fever and septicæmia, the exanthemata and acute rheumatism; but generally in very different degrees, so that its value is questioned in some or all of them. To be of use, the Quinine must be very freely given (10 to 20 gr.) as single doses when the temperature reaches a definite height, say 104° F. Even if apyrexia do not follow, the drug may be of much benefit. In hectic fever Quinine is rarely of much service; and in purely symptomatic fever, of still less.

2. In *splenic enlargement* of malarial origin Quinine is given with success, and in some cases of splenic leukæmia.

3. In *painful nervous affections*, especially neuralgia, headache and face-ache, its effect is well marked. Some of these cases are malarial (brow ague); but ordinary facial neuralgia and toothache will frequently yield to it. Yet Quinine possesses no direct action on peripheral nerves.

4. In certain *cardiac diseases* a combination of Quinine and Digitalis may be of great service, diastole being prolonged and strengthened whilst systole is left unaffected.

5. The **tonic** effect of Quinine has been already referred to. This is also due in part to the removal of fever, and thus of restlessness, sleeplessness and want of appetite. Modifying as it does the metabolic processes in the liver, Quinine may relieve hepatic disorder due to free living, especially in persons who have resided in the tropics.

5. Remote Local Actions and Uses.

Quinine is excreted chiefly in the urine, as the amorphous alkaloid; partly as resinoid and crystalline derivatives. In passing through the urinary organs it is slightly diuretic, and may irritate the passages. It also escapes by the skin, diminishing perspiration, and very rarely causing an itching eruption which resembles that of scarlatina or of measles. All secretions, the milk, and pathological fluids may contain Quinine.

Actions and Uses of the Cinchona Barks.

The Cinchona Barks contain but a small percentage of alkaloids, and are far too bulky for use as antiperiodics and

antipyretics if Quinine can be obtained. They are therefore given only as **bitter stomachics and tonics.** The amount of tannic acid contained in them suggests that they may be used when an astringent effect is also desired, either locally, as in passive diarrhœa, or possibly remotely, as in sweating and chronic mucous discharges; and are to be avoided in constipation, dyspepsia, or irritability of the bowels. The Red Bark is especially astringent.

Actions and Uses of the other Cinchona Alkaloids.

Cinchonine and other alkaloids and products of Bark may be employed as substitutes for Quinine, their actions being very similar. Cinchonine is from $\frac{1}{3}$ to $\frac{1}{2}$ as powerful as Quinine. Cinchonidine is said to cause epileptiform convulsions in animals.

Ipecacuanha.— IPECACUANHA ROOT. The dried root of Psychotria Ipecacuanha.

Characters.—Somewhat tortuous pieces, not often exceeding 6 inches in length, or $\frac{1}{4}$ inch in thickness. Varies in colour from dark brick-red to very dark brown; distinctly annulated externally, the annulations not taking the form of narrow raised ridges (distinction from Carthagena ipecacuanha). Fracture short, exhibiting a thick greyish cortex, usually of a resinous but sometimes a starchy appearance, and a small dense wood. Odour slight; taste bitter.

Composition.—Ipecacuanha contains from $\frac{1}{4}$ to 1 per cent. of *emetine*, which is its active principle; *ipecacuanhic* or *cephaëlic acid*, a glucoside; starch, gum, etc. *Emetine*, $C_{20}H_{30}NO_5$, is a crystalline alkaloid, white—becoming yellow, odourless, bitter, comparatively insoluble in water, forming unstable salts with acids, which are readily dissolved in ordinary media.

Dose, as expectorant, $\frac{1}{4}$ to 2 gr.; as emetic, 15 to 30 gr.

Preparations.

1. **Extractum Ipecacuanhæ Liquidum.**—Alcoholic, with Calcium Hydroxide. *Standardised* to contain 2 to 2·25 per cent. of the alkaloids. *Dose*, as expectorant, $\frac{1}{2}$ to 2 min.; as emetic, 15 to 20 min.

From the Liquid Extract are prepared:

a. **Acetum Ipecacuanhæ.**—1; Diluted Acetic Acid, 17; Alcohol 90 per cent., 2. Contains ·1 per cent. of total alkaloids. *Dose*, 10 to 30 min.

b. **Vinum Ipecacuanhæ.**—1 ; Sherry, 19. Contains ·1 per cent. of total alkaloids. *Dose*, 10 to 30 min. as an expectorant ; as an emetic 4 to 6 fl.dr.

2. **Pulvis Ipecacuanhæ Compositus.** — Dover's Powder. 1 ; Opium, 1 ; Potassium Sulphate, 8. A light fawn-coloured powder. 1 in 10. *Dose*, 5 to 15 gr.

From Dover's Powder is prepared :

PILULA IPECACUANHÆ CUM SCILLA.—Compound Powder of Ipecacuanha, 3 ; Squill, 1 ; Ammoniacum, 1 ; Syrup of Glucose, q.s. 1 in 20. *Dose*, 4 to 8 gr.

3. **Trochiscus Ipecacuanhæ.**—$\frac{1}{4}$ gr., with Fruit Basis.

4. **Trochiscus Morphinæ et Ipecacuanhæ.**—Ipecacuanha, $\frac{1}{12}$ gr. ; Morphine Hydrochloride $\frac{1}{36}$ gr., with Tolu Basis. See *Opium*, page 227.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, Ipecacuanha powder is irritant to the skin, or even pustulant, but it is never used to produce these effects. Exposed mucous membranes are similarly affected by it. If taken as snuff it causes irritation of the nerves, sneezing, and reflex mucous secretion ; and the same effects follow its application as smoke or spray to the pharynx, larynx, or lower air-passages. In some persons it excites asthma. In the form of a spray of the diluted Vinum, or inhaled as the smoke of the burning powder, it is used to relieve cough due to dryness or deficient secretion of the throat and respiratory organs.

Internally.—Reaching the stomach, Ipecacuanha in very small doses (gr. $\frac{1}{4}$) is a **gastric stimulant,** doubtless increasing the local circulation and secretion. It is therefore a useful addition to bitter stomachic and tonic mixtures, and will even arrest vomiting due to certain obscure conditions of the gastric nerves. The Compound Powder is of great value in ulceration of the stomach, and in some forms of dyspeptic vomiting. In doses of 15 to 30 gr., Ipecacuanha acts as an **emetic,** partly by a direct effort upon the stomach, partly by exciting the vomiting centre in the medulla (indirect emesis). This subject will be discussed under the heading of the specific action of the drug.

In the intestines, Ipecacuanha is still a stimulant, increasing the flow of mucus; in large doses an irritant. A remarkable tolerance of the drug is, however, readily established in many persons suffering from **dysentery,** in which disease Ipecacuanha has the power of arresting the inflammatory action in the bowel, checking the liquid and bloody evacuations, and often effecting a complete cure. For this purpose enormous doses (30 to 90 gr.) are given, or large doses frequently repeated.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

Passing through the blood, from the alimentary canal to the tissues, Emetine acts on the vomiting centre in the medulla, *i.e.* is an **indirect emetic,** this effect being added to the direct (gastric) action already mentioned. Ordinary doses (15 to 30 gr. of the powdered root, 3 to 6 fl.dr. of the Vinum for adults) produce free evacuation of the stomach and respiratory passages in 20 to 30 minutes, the dose often having to be repeated in 15 minutes, and vomiting occurring probably but once. Bnt little nausea precedes the emesis, and moderate depression follows it. The circulation and respiration are disturbed and finally depressed, chiefly through the vomiting.

Ipecacuanha is suitable as an emetic in cases where the necessity for evacuation of the stomach is not very urgent, and the subject likely to be benefited by moderate, but injured by great depression. It must not be given, therefore, in poisoning by alkaloids, such as Morphine, but to children and weakly subjects in cases where the after effects of the drug will also be useful. It thus occupies a position amongst emetics between Zinc or Copper Sulphate and Tartar Emetic. Ipecacuanha may be used to empty the stomach in the early stages of sthenic fevers (less commonly than before); in croup, whooping cough, and the bronchitis of children, to expel membranes or mucous products from the air-passages; and in acute dyspepsia with biliousness and heat of skin.

The skin is stimulated to increased secretion by Ipecacuanha, which is used as a **diaphoretic,** combined with Opium (Dover's Powder), in colds, sore throat, and mild rheumatic attacks.

3. REMOTE LOCAL ACTIONS AND USES.

Emetine is excreted by the various mucous membranes, including those of the bronchi, stomach, and bowels, and by the liver. On the bronchi it produces the same remote as immediate local actions, namely, stimulation of the nerves,

reflex cough, increased secretion, and, in large doses, even inflammation of the mucous membrane and lungs. Ipecacuanha is thus an expectorant, increasing at once the expulsive acts, and the amount, that is the liquidity, of the sputa. It is the most generally used of all this class of measures, being given in acute and chronic bronchitis, in phthisis, and in most cases of cough when the phlegm is scanty and tough. Its special advantages are, that, if taken in excess, it causes sickness, which is often beneficial in the bronchitis of children; and that as a diaphoretic and moderate depressant of the circulation, *i.e.* a **sedative expectorant,** it controls the accompanying fever.

Acting remotely on the liver, this drug is a **direct cholagogue,** increasing the secretion of bile; and has long been a favourite constituent of some purgative pills and aperient draughts for chronic biliousness and gouty dyspepsia.

Catechu.—CATECHU. Catechu Pallidum. An extract of the leaves and young shoots of Uncaria Gambier.

Characters.—Cubes, separate or agglutinated, about 1 inch square; deep reddish-brown externally, pale cinnamon-brown internally; porous, friable; microscopically presenting myriads of acicular crystals. No odour; taste bitter, very astringent, then sweetish. *Solubility.*—Almost entirely in boiling water; 70 per cent. in Alcohol 90 per cent.

Composition.—Catechu chiefly contains a crystalline bitter substance, *catechin* or *catechuic acid*, $C_{13}H_{12}O_5$, probably itself inactive; and *catechu-tannic* acid, the active principle, isomeric with it, into which it is rapidly converted by boiling or by the action of saliva, with the development of a red colour. Both acids give a green precipitate with ferric salts. *Incompatibles.*—The alkalis, metallic salts, and gelatin. *Impurity.*—Starch. *Dose*, 5 to 15 gr.

Preparations.

1. **Pulvis Catechu Compositus.** — 4; Kino, 2; Krameria, 2; Cinnamon, 1; Nutmeg, 1. *Dose*, 10 to 40 gr.

2. **Tinctura Catechu.**—4; Cinnamon Bark, 1; Alcohol 60 per cent., 20; by maceration. *Dose*, ½ to 1 fl.dr.

3. **Trochiscus Catechu.**—1 gr., with Simple Basis.

ACTIONS AND USES.

Catechu acts like Tannic Acid, and is used for the same purposes (*see* page 394). It is a favourite **astringent** application to sore throat in the form of the Lozenge and the Compound Powder and Tincture are very commonly prescribed for diarrhœa.

Caffeina.—CAFFEINE. THEINE. $C_5H(CH_3)_3N_4O_2,H_2O$. *Source.*—Usually obtained from the dried leaves of Camellia Thea, the tea plant (N.O. Ternströmiaceæ), or the dried seeds of Coffea arabica, the coffee plant.

Characters.—Colourless, silky, acicular, inodorous crystals. *Solubility.*—1 in 80 of cold water, the solution faintly bitter, and neutral; easily soluble in boiling water, alcohol 90 per cent., or chloroform; sparingly in ether. Treated with a crystal of $KClO_3$ and HCl, and the mixture evaporated to dryness in a porcelain dish, a reddish residue results, which becomes purple when moistened with NH_4HO. In aqueous solution, tannic acid gives a white precipitate, soluble in excess; but no precipitate is caused by solution of potassium iodide containing Mercuric iodide (distinction from other official alkaloids).

Tea contains 1 to 4 per cent. of Caffeine, with tannic acid, volatile oil, etc.; Coffee, about 1·3, with volatile oil, sugar, tannic acid, etc.; Maté, 1·2; Guarana 5 per cent. It is closely allied to theobromine, $C_5H_2(CH_3)_2N_4O_2$, dimethyl-xanthine, being, in fact, trimethyl-xanthine, which can be made synthetically. *Incompatibles.*—Tannic acid, potassium iodide, and salts of mercury. *Dose*, 1 to 5 gr.

From Caffeina is made:

Caffeinæ Citras.—CAFFEINE CITRATE. $C_8H_{10}N_4O_2$, $C_6H_8O_7$. An unstable compound prepared from Caffeine and Citric Acid.

Source.—Made by dissolving Citric Acid and Caffeine in hot water; evaporating to dryness; and pulverising.

Characters.—A white inodorous powder, with an acid, faintly bitter taste; reaction acid. *Solubility.*—1 in 32 of water; also in a mixture of 2 of chloroform and 1 of alcohol 90 per cent. With 13 of water it forms a clear syrupy solution, which on dilution yields a white precipitate of Caffeine, redissolving in excess of

water. Reactions otherwise as of Caffeine. *Dose*, 2 to 10 gr.

Preparation.

Caffeinæ Citras Effervescens.—Effervescent Caffeine Citrate. Made like Sodii Citro-tartras Effervescens (page 42), with the addition of Caffeine Citrate. *Dose*, 60 to 120 gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Coffee stimulates most of the digestive glands, being sialagogue, **stomachic and slightly laxative.** So far it is dietetically wholesome.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

Caffeine is absorbed into the circulation unchanged; and acts chiefly upon the central nervous system. The **cerebrum is first stimulated** both directly and through the blood-pressure, whence the clearness of intellect and the sleeplessness familiar after a cup of strong tea or coffee. Larger doses cause a species of narcotism; but there are great personal differences in this and other respects. In the lower animals the spinal centres are simultaneously affected to such a degree that tetanic convulsions may occur, not unlike those caused by Strychnine; in man these effects on the lower centres are quite subsidiary. The sensory and motor peripheral nerves are not certainly affected. The muscle curve is altered in character, and **muscular contraction seems more easily executed.** Caffeine first **strengthens and lengthens the cardiac systole,** whilst diastole is shortened. Finally, it arrests the heart in diastole. When taken in excess or by certain susceptible individuals, coffee or tea gives rise to cardiac distress. The **renal vessels are dilated.** The **blood-vessels are first constricted, then dilated, and finally constricted.** Respiration is temporarily increased, then depressed. Metabolism is little influenced; the temperature is raised. Habit markedly weakens the influence of Coffee.

Coffee or Caffeine may be used as a nervine stimulant and restorative in fatigue and in narcotic poisoning. Megrim is frequently relieved by either. It is given with benefit in cardiac disease, especially failure of compensation with dropsy; being more rapid and less irritant than Digitalis. The Citrate, being

a weak salt, should be combined with Sodium Salicylate or Benzoate, to form a more stable compound. Large doses must be avoided. Coffee often relieves asthma.

3. REMOTE LOCAL ACTIONS AND USES.

But a small proportion of Caffeine is excreted unchanged in the bile and urine. In passing through the kidneys, it or its products appear to stimulate the cells; and in this way, as well as by its influence on the heart and vessels, it acts as a **diuretic.** The Citrate is a powerful but somewhat uncertain remedy in dropsy, whether cardiac or hepatic, occasionally producing a profuse flow of urine when all other means have failed. It is best given after or with a stimulant diuretic such as Digitalis; for a short time only; and in moderate doses.

VALERIANACEÆ.

Valerianæ Rhizoma. — VALERIAN RHIZOME. Valerian Root. The dried erect rhizome and roots of Valeriana officinalis. Collected in the autumn.

Characters.—Short, erect, entire, or sliced; dark yellowish-brown externally; with numerous slender brittle roots, 3 or 4 inches long, of the same colour; rhizome and roots whitish or yellowish internally. Odour on drying, strong, characteristic, disagreeable; taste unpleasant, camphoraceous, slightly bitter. *Substances resembling Valerian:* Serpentary and Arnica, known by odour.

Composition.—The active principles are (1) a *volatile oil*, and (2) *valerianic acid.* (1) The *oil* consists of a terpene, *valerene or borncëne*, $C_{10}H_{16}$, and *valerian camphor*, $C_{12}H_{20}O$, *valerol.* (2) *Valerianic acid*, iso-valerianic acid, $HC_5H_9O_2$, occurs in many other plants, and in cod-liver oil; and can be derived from amylic alcohol (valeryl-aldehyde), $C_5H_{11}HO$. by oxydation. It is a colourless oily fluid, with a powerful odour and acrid burning taste; soluble in 30 parts of water, freely in alcohol and ether.

Preparations.

A. *Of Valerianæ Rhizoma:*

Tinctura Valerianæ Ammoniata.—20; Oil of Nutmeg, ·31; Oil of Lemon, ·21; Solution of Ammonia, 10; Alcohol 60 per cent., 90; by maceration. *Dose.* ½ to 1 fl.dr.

B. *Containing Valerianic Acid:*

Zinci Valerianas.—Zinc Valerianate. Zinc Iso-valerianate. $Zn(C_5H_9O_2)_2$.

Source.—Made by saturating Iso-valerianic Acid with Zinc Carbonate, or by the interaction of Zinc Sulphate and Sodium Iso-valerianate. $ZnSO_4 + 2(NaC_5H_9O_2) = Zn(C_5H_9O_2)_2 + Na_2SO_4$.

Characters.—White pearly tabular crystals, with a disagreeable odour and a metallic taste. *Solubility.*—Very slightly in cold water or in ether; soluble in hot water, and alcohol 90 per cent. *Incompatibles.*—All acids, soluble carbonates, most metallic salts, vegetable astringents. *Impurities.*—Sulphate and butyrate of zinc. *Dose*, 1 to 3 gr.

ACTIONS AND USES.

Valerian acts essentially like other substances containing volatile oils, but its pungent taste and peculiarly disagreeable odour increase the effect on the central nervous system. The stomach and intestines, heart, circulation and brain are influenced as they are by Cloves (*see* page 291), and the oil is excreted in the urine, breath and sweat, as is also the acid.

Valerian is used as a powerful **carminative, circulatory stimulant and antispasmodic**, in hysterical flatulence, fainting, palpitation, convulsions and *contractures*. It is now but rarely given in other spasmodic affections, such as epilepsy.

Zinc Valerianate was introduced to combine the specific action of the metal on the nervous system with the antispasmodic influence of the plant, and has been given in hysteria and epilepsy; but Valerianic Acid does not appear to possess the action of the volatile oil just described.

COMPOSITÆ.

Pyrethri Radix.—Pyrethrum Root. Pellitory Root. The dried root of Anacyclus Pyrethrum.

Characters.—In unbranched pieces, from 2 to 4 inches long, and ½ inch or more thick; nearly cylindrical, or frequently tapering towards both apex and base, the latter often bearing a tuft of nearly colourless hairs. Outer surface brown, and longitudinally wrinkled. Fracture short, showing the wood traversed by large medullary rays in which, as in the cortex, numerous dark resin-ducts are scattered. Odour distinct, characteristic; taste pungent, the root exciting a

copious flow of saliva when chewed. *Substance resembling Pellitory:* Taraxacum, which is darker and of different taste.

Composition.—Pyrethrum contains one or more *volatile oils*, and *resins; inulin*, $C_6H_{10}O_5$, a white powder occupying the place of starch in the roots of this and some other plants; and possibly a substance allied to *piperine*, see *Piper Nigrum*, page 385.

Preparation.

Tinctura Pyrethri.—1 in 5 of Alcohol, 70 per cent.; by percolation.

ACTIONS AND USES.

Pellitory causes a sharp burning sensation in the mouth followed by persistent tingling and numbness, and a profuse flow of saliva, stimulating as it does the local nerves and vessels, and afterwards depressing the former. It is used chiefly as a **sialagogue** in dryness of the throat; and to give a "clean" taste to flat dentifrices, such as chalk.

Pyrethrum Roseum.—(*Not official*). The powder of the flower-heads.—Used as insect powder, its active ingredient being a resin soluble in ether.

Santoninum.—Santonin. $C_{15}H_{18}O_3$.

Source.—Prepared from Santonica, the dried unexpanded flower-heads or capitula of Artemisia maritima, *var.* Stechmanniana.

Characters.—Colourless flat rhombic prisms, feebly bitter, fusible and volatile when gently heated. *Solubility.*—Scarcely in cold, sparingly in boiling, water; 1 in 4 of chloroform; 1 in 40 of cold, and 1 in 3 of boiling, alcohol 90 per cent. Sunlight renders it yellow. Added to warm alcoholic solution of potassium hydroxide, it yields a violet red colour. Santonin forms Santonates with alkalis, from which HCl liberates Santonic Acid, readily reconverted into Santonin. *Dose*, 2 to 5 gr.

Preparation.

Trochiscus Santonini.—1 gr., with Simple Basis.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Santonin acts as a poison on the *Ascaris lumbricoides* or round worm, which infests the intestine; decidedly less on the *Oxyuris vermicularis* or thread-worm. It is used as an

anthelmintic against the former parasite, combined with a purgative vermifuge, such as Pulvis Scammonii Compositus, or followed in a few hours by a laxative, such as Castor Oil.

2. Actions in the Blood; Specific and Remote Local Actions.

Santonin is absorbed into the blood as sodium santonate; enters the tissues; and produces peculiar **disturbances of vision**, and of the brain and spinal cord. Objects appear first blue and then yellow (chromatopsia); and finally colour vision is almost lost. **Consciousness is disturbed**, with a kind of intoxication, aphasia, tremors, and convulsions after large doses. Respiration is enfeebled, and the pulse reduced in frequency. These effects must be carefully avoided. Santonin is excreted by the kidneys as an obscure product of its oxydation in the system, which colours the (acid) urine greenish-yellow (alkaline urine red or purple) and causes some diuresis; it is also excreted by the bowel. It has been used as an emmenagogue with various success.

Anthemidis Flores.—Chamomile Flowers. The dried expanded flower-heads of Anthemis nobilis. Collected from cultivated plants.

Characters.—About ½ to ¾ inch in diameter, hemispherical; white or nearly white. Involucre composed of several rows of oblong bracts with membranous margins; receptacle solid, conical, densely covered with concave, blunt, narrow, scaly bracts; florets mostly ligulate, white. Odour strong, aromatic; taste bitter.

Composition.—Chamomile Flowers contain 0·2 per cent. of the official *volatile oil*, and a *bitter extractive*.

Preparations.

Extractum Anthemidis.—A concentrated decoction, *with the addition of Oleum Anthemidis. Dose* 2 to 8 gr.

From Anthemidis Flores is made:

Oleum Anthemidis. — The oil distilled from Chamomile Flowers.

Characters.—Pale blue or greenish-blue, becoming yellowish-brown; of aromatic odour and taste. Sp. gr., ·905 to ·915. It is composed of a terpene, $C_{10}H_{16}$, and an oxydised

portion, $C_{10}H_{16}O_2$, which yields angelic acid, $HC_5H_7O_2$. *Dose*, ½ to 3 min.

Oil of Chamomile is used in preparing Extractum Anthemidis.

ACTIONS AND USES.

Externally.—Warm infusions or decoctions of Chamomile, or the Flowers in bags soaked in hot water, possess the general properties of fomentations and poultices, the high temperature being apparently the active influence. They are much used as a domestic application to painful parts.

Internally.—Chamomile belongs to the class of **aromatic bitter stomachics**. A warm infusion, freely drunk, is a mild simple **emetic**, which may be used in biliousness, ague, etc. The Oil or the Extract is usefully combined with purgative pills as a stomachic and carminative.

Taraxaci Radix.—DANDELION ROOT. The fresh and dried roots of Taraxacum officinale. Collected in the autumn.

Characters.—Fresh root a foot or more long, ½ an inch or more in diameter; smooth, yellowish-brown externally; whitish within. Fracture short; juice milky; the surface presenting faint concentric rings. Dried root shrivelled, deeply wrinkled longitudinally, dark brown or blackish; fracture short; exposed surface showing a yellow porous woody axis, and a thick whitish cortex with irregular concentric rings. Inodorous; taste bitter. *Substance resembling Taraxacum*: Pellitory; pungent when chewed.

Composition.—Taraxacum Root contains an amorphous neutral principle *taraxacin; potassium and calcium salts; inulin;* and *resinoid bodies*, which give the milky appearance to the juice. The relative richness of the constituents varies with the season and situation.

Preparations,

1. **Extractum Taraxaci.**—The juice of the *fresh* root evaporated to a soft consistence. *Dose*, 5 to 15 gr.

2. **Extractum Taraxaci Liquidum.**—1 of the *dried* root in 1 of Alcohol 60 per cent. and Water. *Dose*, ½ to 2 fl.dr.

3. **Succus Taraxaci.**—*Fresh* juice, 3; Alcohol 90 per cent., 1. *Dose*, 1 to 2 fl.dr.

ACTIONS AND USES.

Taraxacum combines the properties of its two principal constituents, the bitter taraxacin and the alkaline salts, *i.e.* it is at once a simple **bitter** and a mild **laxative.** It is therefore indicated, and was formerly extensively given, in atonic dyspepsia attended by habitual constipation; and its preparations may be added to stomachic mixtures and laxative pills. Until recently Taraxacum was believed to be a cholagogue; but this effect, if it exist at all, appears to be indirect only.

Arnicæ Rhizoma.—ARNICA RHIZOME. Arnica Root. The dried rhizome and roots of Arnica montana.

Characters.—Cylindrical, horizontal, dark brown, 1 to 2 inches long; $\frac{1}{6}$ to $\frac{1}{4}$ inch in thickness; curved, rough from scars and remains of fallen leaves; giving off numerous brittle wiry roots, and usually terminated by hairy remains of stem and leaves. Odour peculiar, faintly aromatic; taste acrid, bitter. *Substances resembling Arnica*: Valerian, known by odour; Serpentary, by odour.

Composition.—Arnica contains a small quantity of ***volatile oil,*** of complex composition, and said to yield *trimethylamin; tannic acid;* and an active resinous glucoside, *arnicin,* $C_{20}H_{30}O_4$.

Preparation.

Tinctura Arnicæ.—1 in 20 of Alcohol 70 per cent. by percolation.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Arnica, applied to the skin, sometimes causes hyperæmia, eczema and even spreading erysipelas. It would, therefore, appear to **increase the activity of the circulation in the skin**; and the Tincture in water is a popular application to bruises, preventing swelling and hastening the absorption of effused blood. It must be used with caution.

Internally.—Arnica is a **stimulant to the alimentary canal,** like volatile oils in general; in over-doses it is a powerful irritant. Probably by reflex action from the stomach (see *Caryophyllum,* page 291) it stimulates the heart and circulation, the brain and spinal cord, in moderate doses. Arnica

has been used in low fevers, delirium tremens and mental disorders.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

The active principles of Arnica enter the blood and thence the tissues, where its effects somewhat resemble those of Turpentine. If the dose be considerable, the reflex stimulant effect from the stomach is overcome by its **depressing** action on the **circulation and nerve centres**; headache, unconsciousness and convulsions being induced, and the body temperature lowered. Arnica cannot be said to be used now as an antipyretic.

3. REMOTE LOCAL ACTIONS AND USES.

Like its allies, Arnica is a remote stimulant of the kidneys and skin, and has been given in some cutaneous diseases such as eczema, and in chronic rheumatism.

LOBELIACEÆ.

Lobelia.—LOBELIA. The dried flowering herb of Lobelia inflata.

Characters.—Stems angular, channelled, with narrow wings; often of a purplish tint, with one-celled hairs and the scars of alternate leaves. Leaves irregularly toothed and hairy. Capsules inflated, two-celled; containing when mature minute, oblong, reticulated brown seeds. Odour somewhat irritating; taste at first not marked, but burning and acrid after chewing.

Composition.—Lobelia contains *lobeline*, an oily, liquid, volatile alkaloid, with a pungent taste, and an odour like tobacco. *Lobelic acid* is united with the lobeline. *Incompatibles:* The caustic alkalis, which decompose lobeline.

Preparation.

Tinctura Lobeliæ Ætherea.—1 in 5 of Spirit of Ether; by percolation. *Dose*, 5 to 15 min.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Lobelia is a **gastro-intestinal stimulant**; in large doses an irritant, causing vomiting, pain, purging and the ordinary symptoms of depression. It is not to be employed as an

emetic, but is believed to be sometimes useful in obstinate constipation.

2. Actions in the Blood, and Specific Actions and Uses.

The active principles of Lobelia appear to enter the blood and tissues, where severe specific effects are produced by free doses, including general depression, muscular tremors and weakness, giddiness, headache, failure of the heart and breathing, and cold perspirations: a condition resembling collapse. The exact mode of action of the drug is not known. It appears to depress the convolutions secondarily only; to lower the activity of the motor centres in the cord, and cause muscular relaxation; to **depress the respiratory centre and relax the bronchial muscles**; and to diminish the force of the heart and the tension of the vessels, after brief increase of the latter. Lobelia kills through the respiratory centre, like its ally Tobacco, and not through the heart.

Lobelia is a favourite remedy with some practitioners for the paroxysm of asthma, for which it should be given at the commencement in doses of ½ fluid drachm of the Tincture, repeated every thirty minutes until nausea is produced. In 10 min. doses, it is a useful addition to expectorant mixtures for bronchitis with spasm and very scanty tough sputum.

3. Remote Local Actions and Uses.

Lobeline is probably excreted by the kidneys and skin, and acts as a diuretic and diaphoretic. Except indirectly, these effects are not taken advantage of in medicine.

ERICACEÆ.

Uvæ Ursi Folia.—Bearberry Leaves. The dried leaves of Arctostaphylos Uva ursi.

Characters. — Yellowish-green, obovate or spathulate, coriaceous leaves, about ¾ inch in length; entire, very shortly petiolate. Upper surface glabrous, shining, reticulate; the veinlets are depressed. No marked odour; taste very astringent. *Substances resembling Uvæ Ursi Folia:* Senna and Buchu, *q.v.*

Composition.—Uva Ursi contains a bitter crystalline glucoside, *arbutin*, $C_{12}H_{16}O_7$, soluble in water, yielding glucose and a mixture of hydrochinon (*see* page 198) and methyl-hydrochinon; a second glucoside, *ericolin*, $C_{34}H_{56}O_{21}$; 33 per cent

of *tannic* and *gallic acids*; and a crystalline neutral body, *ursone*. *Incompatibles.*—Iron, lead and silver salts; alkaloids; gelatin.

Preparation.

Infusum Uvæ Ursi.—1 in 20 of boiling Water. *Dose*, ½ to 1 fl.oz.

ACTIONS AND USES.

Uva Ursi possesses much the same actions as Pareira and Buchu, but it is more astringent in virtue of the tannic acid which it contains. The arbutin appears in the urine partly as hydrochinon-sulphuric acid (*see* page 198). Uva Ursi is used as a remote **astringent, stimulant, diuretic and disinfectant** in diseases **of the urino-genital tract**, such as chronic catarrh of the pelvis of the ureter, bladder and urethra.

SAPOTACEÆ.

Caoutchouc.—INDIA-RUBBER. The prepared milk-juice of Hevea brasiliensis and probably other species. Known as pure Para rubber.

Characters.—Brownish-black elastic masses varying in thickness, somewhat mottled internally. Odour characteristic, somewhat empyreumatic; nearly tasteless. *Solubility.*—Insoluble in water, ethylic alcohol, alkaline solutions, or dilute acids; soluble in chloroform, oil of turpentine, carbon bisulphide, benzol and petroleum spirit.

Composition.—Caoutchouc consists of hydrocarbons, usually slightly oxydised; it yields a terpene, *caoutchin*, on distillation.

Preparation.

Liquor Caoutchouc.—1, dissolved in a mixture of 10 each of Benzol and Carbon Bisulphide.

Solution of India-rubber is used in preparing Charta Sinapis.

USES.

India-rubber is employed for making surgical instruments and apparatus. The Solution is used as **a vehicle** for a variety of external applications.

STYRACEÆ.

Benzoinum.—Benzoin. A balsamic resin obtained from Styrax Benzoin, and probably from other species of Styrax. Known as Siam and Sumatra benzoin.

Characters.—In flat or curved tears varying in size, but seldom exceeding 2 inches in length and $\frac{1}{2}$ inch in thickness; yellowish- or reddish-brown externally, milky white internally; or in masses composed of tears closely agglutinated owing to the presence of a reddish-brown translucent, or greyish-brown opaque, resinous substance. It is brittle but softens readily when warmed, and when further heated yields fumes of benzoic acid. Odour agreeable, recalling that of vanilla in the case of Siam benzoin, and storax in the case of Sumatra benzoin. *Solubility.*—Almost entirely soluble in alcohol 90 per cent., and in solution of potassium hydroxide.

Substances resembling Benzoin: Gum-resins and resins; distinguished by odour and taste.

Composition.—Benzoin contains 12 to 20 per cent. of the official *benzoic acid;* a trace of *cinnamic acid*, $C_6H_5 \cdot CH \cdot CH \cdot COOH$ (*see* page 391); two *resins* and a *volatile oil.*

Preparations.

1. **Adeps Benzoatus.**—3 to 100 nearly of Lard.

2. **Tinctura Benzoini Composita.**—Friar's Balsam. 10; Prepared Storax, 7·5; Balsam of Tolu, 2·5; Socotrine Aloes, 1·83; Alcohol 90 per cent., to make 100. By maceration. *Dose*, $\frac{1}{2}$ to 1 fl.dr. (in emulsion).

Benzoin is also contained in Unguentum Cetacei.

From Benzoinum is made:

Acidum Benzoicum.—Benzoic Acid. $C_6H_5 \cdot COOH$.

Source.—May be obtained from Benzoin by sublimation. It is also obtained from toluene, hippuric acid, and other organic compounds.

Characters and Tests.—In light feathery crystalline plates and needles; flexible; nearly colourless; and odourless when quite pure, but when obtained from benzoin with an agreeable aromatic odour, due to traces of volatile oils. *Solubility.*—1 in 400 of cold, 1 in 17 of boiling, water; 1 in 1 of absolute alcohol; 1 in 3 of alcohol 90 per cent.; 1 in 2·5 of ether; 1 in 7 of chloroform, and in the fixed and volatile oils; also in solutions of the alkalis and of calcium hydroxide,

forming benzoates, and precipitated from these on the addition of hydrochloric acid unless the solutions be very dilute. Volatilises in the vapour of water. Sodium phosphate or borax aids its solubility in water (1 of borax and 1 of acid soluble in 100 of water). *Impurities.*—Hippuric, cinnamic, oxalic and chlorobenzoic acids. *Dose*, 5 to 15 gr.

Preparation.

TROCHISCUS ACIDI BENZOICI.—½ gr., with Fruit Basis.

Benzoic Acid is also contained in Tinctura Camphoræ Composita and Tinctura Opii Ammoniata. See *Opium*, page 226.

From Acidum Benzoicum are made:

1. **Ammonii Benzoas.**—Ammonium Benzoate. $C_6H_5 \cdot COONH_4$. *Source.*—Made by neutralising Benzoic Acid with Solution of Ammonia.

Characters.—Colourless lamellar crystals, with the fragrant odour of Benzoic Acid. *Solubility.*—1 in 6 of water; 1 in 30 of alcohol 90 per cent.; 1 in 8 of glycerin. Sublimes without residue. *Impurities.*—Chlorides and sulphates; free acid. *Incompatibles.*—Ferric salts, liquor potassæ and acids. *Dose*, 5 to 15 gr.

2. **Sodii Benzoas.**—Sodium Benzoate. $C_6H_5 \cdot COONa$. *Source.*—Made by neutralising Benzoic Acid with Sodium Carbonate.

Characters.—A white crystalline or amorphous powder; odour none, or faintly benzoic; taste unpleasant, sweetish, saline; reaction faintly alkaline. *Solubility.*—1 in less than 2 of cold water; 1 in 24 of cold, 1 in 12 of boiling, alcohol 90 per cent. *Impurities.*—Many metals; and other salts. *Dose*, 5 to 30 gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Benzoin and its preparations are **antiseptic and disinfectant**, and at the same time slightly **stimulant** to the vessels. The Compound Tincture, Friar's Balsam, has long been used as an application to ulcers and foul wounds, and also to promote the healing of freshly incised wounds.

Internally.—Benzoin and its Acid cause sneezing and coughing when inhaled or applied in the solid form to the nose; much diluted with watery vapour, they are mild stimulants. The Compound Tincture is thus a useful substance for inhalation or spray in many laryngeal diseases.

Taken by the mouth, Benzoic Acid causes slight heat and irritation in the stomach; the salts are less irritant.

2. Actions in the blood, and uses.

Benzoin and Benzoic Acid enter the blood in the form of sodium benzoate; and here, as well as in the kidneys, the acid is **partly converted into hippuric acid** by combination with a molecule of glycocine, thus: $C_7H_6O_2 + CH_2{\cdot}COOH{\cdot}NH_2$ (glycocine) $= COOH{\cdot}CH_2NH{\cdot}CO{\cdot}C_6H_5$ (hippuric acid) $+ H_2O$. The exact source of the glycocine is obscure. It is not derived from the urea or uric acid, as was once suggested.

3. Specific actions and uses.

Benzoic Acid and its salts are **antipyretic**, and are said to **increase metabolism.**

4. Remote local actions and uses.

Benzoic Acid is excreted by the kidneys, partly unchanged, partly as hippuric acid, and occasionally as succinic acid, increasing the flow of urine; by the skin and salivary glands, unchanged, stimulating their secretions; and probably by the respiratory organs, decidedly increasing the amount of expectoration. These remote local effects are turned to useful account. The Acid and its Ammonium salt are extremely valuable in inflammation of the bladder with alkalinity of the secretion and phosphatic deposits, by **acidulating the urine and stimulating and disinfecting the mucous surfaces.** As an **expectorant**, Benzoic Acid, chiefly as the Compound Tincture, or contained in Tinctura Camphoræ Composita, Tinctura Opii Ammoniata, and the Balsams of Tolu and Peru, is very useful in chronic bronchitis, when the bronchial products are abundant, thick and possibly foul, the mucous membrane chronically inflamed and weak, and reflex activity low.

OLEACEÆ.

Oleum Olivæ.—Olive Oil. The oil expressed from the ripe fruit of Olea europæa.

Characters.—Pale or greenish-yellow, with a faint odour and a bland taste; Sp. gr. ·914 to ·919; congeals partially at 32° F.

Composition.—Olive Oil consists of 72 per cent. of a fluid oil, *olein*, $C_3H_5(C_{18}H_{33}O_2)_3$, and 28 per cent. of a solid oil or stearoptene, *palmitin*, $C_3H_5,(C_{16}H_{31}O_2)_3$. These are compounds of a radical, *glyceryl*, C_3H_5, with *oleic acid*, $HC_{18}H_{33}O_2$, and *palmitic acid*, $HC_{16}H_{31}O_2$, respectively. *Impurities.*—Cotton-seed oil.

Preparations.

Many Emplastra, Linimenta and Unguenta. It is also the source of Hard and Soft Soaps and of Glycerin.

Sapo Durus.—HARD SOAP. Sodium Oleate. *Source.*—Made with Olive Oil and Sodium Hydroxide. $C_3H_5(C_{18}H_{33}O_2)3 + 3NaHO = 3NaC_{18}H_{33}C_2 + C_3H_5(OH)_3$. "Castile Soap."

Characters.—Greyish-white, dry. Inodorous. Horny and pulverisable when kept in warm dry air. *Solubility.*—Soluble in alcohol 90 per cent.; 1 in 20 of cold, and 1 in 1½ of hot, water. *Impurities.*—Excess of alkaline hydroxide or carbonate, detected by the phenol-phthalein test.

Preparation.

Pilula Saponis Composita.—Opium, 1; Hard Soap, 3; Syrup of Glucose, 1. *Dose*, 2 to 4 gr. See *Opium*, page 225.

Sapo Durus is also used in the preparation of many other pills.

Sapo Mollis.—SOFT SOAP. Potassium Oleate.

Source.—Made with Olive Oil and Potassium Hydroxide.

Characters.—Yellowish-white or -green, almost inodorous, of unctuous consistence. *Solubility.*—Readily soluble in alcohol 90 per cent., especially on warming. *Impurities.*—Correspond with those of Hard Soap; also oil and copper.

Preparation.

Linimentum Saponis.—8; Camphor, 4; Oil of Rosemary, 1·5; Alcohol 90 per cent., 64; Water, 16.

Sapo Mollis is contained in Linimentum Terebinthinæ; *Linimentum Saponis in* Linimentum Opii.

[**Sapo Animalis**, Curd Soap, is made with *animal* fat. *See* page 428.]

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally applied, Olive Oil renders the skin smoother, softer, and more flexible. It is used to facilitate friction over enlarged bones or stiff joints; and in the form of liniments, to bring active bodies, such as Ammonia and Lime, more thoroughly into contact with the surface in a mild form. It is also an excellent **mechanical application** to burns and certain skin diseases, by coating the surface and excluding air. and in the treatment of the effects of corrosive acids and alkaloids. Inunctions with Olive Oil to which $\frac{1}{20}$ part of Phenol has been added are ordered in the desquamative stage of scarlet fever as a disinfectant measure. Oil rubbed into the skin is absorbed by the lymphatics, and has a distinctly **nutritive** effect, of which use may be made in wasted children when the stomach rejects food.

Internally, Oils may be similarly given in corrosive poisoning. In the stomach they are not specially changed; in the intestines they are partly emulsified, mainly saponified, glycerin being set free, and their fatty acids combining with free alkalis to form soaps. With many persons excess of Oil causes dyspepsia and loathing, especially in warm weather; with most subjects some relaxation of the bowels or diarrhœa. As an enema, Olive Oil is **laxative**, and is used in fæcal impaction and obstruction of the bowels.

2. ACTIONS IN THE BLOOD, SPECIFIC ACTIONS AND USES AND REMOTE LOCAL ACTIONS.

Olive Oil enters the blood from the lacteals or lymphatics and may be traced in it if given in excess. Thence it reaches all the cells of the body, especially those of the connective tissues, the amount varying with a number of circumstances. Here it is fully oxydised into carbonic acid and water, and constitutes a **food**, increasing the amount of fat in the tissues, furnishing force, and thus saving the waste of nitrogenous tissue, and the necessity of consuming quantities of nitrogenous food, but unable of itself to support life.

Oils and fats are used in many forms (Olive and other vegetable oils, Butter, Cream, Cod-liver Oil, etc.) in wasting diseases, such as scrofula and phthisis, as is fully discussed under *Oleum Morrhuæ*, page 436. Olive Oil is rarely used in Great Britain, but may be taken by some patients, in the form of Sardine Oil, when Cod-liver Oil is rejected.

Oils are excreted as carbonic acid and water, but excess

will appear unchanged in the urine. Olive Oil is not a special renal irritant like Linseed Oil.

Glycerinum.—GLYCERIN. Glycerol. A trihydric alcohol, $C_3H_5(OH)_3$, containing a small percentage of water.

Source.—Obtained by the interaction of alkalis, or of superheated steam, with fats and fixed oils.

Characters.—A clear colourless syrupy liquid, without odour, of a sweet taste; miscible with water and alcohol 90 per cent.; neutral; insoluble in ether, chloroform, and fixed oils. It absorbs moisture when exposed to the air. When decomposed by heat it evolves intensely irritating vapours. Sp. gr. 1·260. It is the trihydroxyl derivative, or alcohol, of a hydrocarbon radical glyceryl, C_3H_5, which, in combination with fatty acids, forms fixed oils. It is separated in the hydrated form when oils are decomposed by alkaline hydrates (*saponification*), or by water (hydrogen hydrate) at high temperatures; and is thus a by-product in making soaps and Lead Plaster (*see* page 65). *Impurities.*—Lead, copper, arsenium, iron, calcium, potassium, sodium, ammonium, chlorides and sulphates; cane and grape sugars; foreign organic matter; butyric acid; and fixed mineral matter. *Dose.* 1 to 2 fl.dr.

Preparations.

1. **Glycerinum Acidi Borici.**—14 in 20; heated.
2. **Glycerinum Acidi Carbolici.** — Glycerin of Phenol. 5 in 6; by solution.
3. **Glycerinum Acidi Tannici.**—5 in 6; by solution.
4. **Glycerinum Aluminis.**—6 in 7 fully, with Water; gently heated.
5. **Glycerinum Amyli.**—6½ in 9 with Water; heated until a jelly is formed.
6. **Glycerinum Boracis.**—6 in 7; by solution.
7. **Glycerinum Pepsini.**—12 in 20; by maceration. See *Pepsinum*, page 431.
8. **Glycerinum Plumbi Subacetatis.**—20 in 32·7, boiled and evaporated. See *Plumbum*, page 67.
9. **Glycerinum Tragacanthæ.**—3 in 5, with Water; by solution. See *Tragacantha*, page 267.
10. **Suppositoria Glycerini.**—70 per cent. by weight; with Gelatin and Water.

Glycerin is also used in preparing Linimentum Potassii Iodidi cum Sapone, Mel Boracis, all the Lamellæ; and in many other preparations.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Glycerin is a slightly **stimulant, antiseptic, hygroscopic** and adhesive substance, which forms a useful addition to lotions and other applications for the skin, when a desiccant effect is not undesirable. Rubbed freely into the hands at night it effectually prevents dryness and chapping of the skin in cold weather. Its remarkable powers mechanically and as a solvent also render it invaluable in lotions.

Glycerin is readily absorbed by the unbroken skin, and will carry in with it alkaloids or other active substances, such as the atropine in Extract of Belladonna.

Internally.—Glycerin is **very sweet,** and imparts a smooth, sweet agreeable taste to nauseous or astringent mixtures, rendering the addition of sugar unnecessary. As a topical stimulant and **demulcent,** it is an excellent vehicle of such applications for sore throat as Tannic Acid. In the stomach it has no special action. In the form of Suppository or enema it is **laxative.**

2. ACTIONS ON THE BLOOD.

Glycerin is freely absorbed by all surfaces, and is one of the normal products of the digestion of oils and fats in the intestines. In large quantity it is said to cause the solution of the red corpuscles, the diffusion of the hæmoglobin in the plasma, and consequent hæmoglobinuria.

3. SPECIFIC ACTIONS AND USES.

Glycerin has been supposed to be **nutritive,** and may contribute to the formation of adipose tissue, as a portion of the fats and oils of food are decomposed in intestinal digestion, and the glyceryl again united with the fatty acid in the process of absorption by the villi. The results obtained from the administration of Glycerin instead of oils in phthisis have been very divergent, and on the whole not encouraging. The same may be said of its use in diabetes mellitus.

4. REMOTE LOCAL ACTIONS AND USES.

Glycerin is decomposed in the system, and passes out as propionic, formic and other acids. The urine of persons taking Glycerin contains a reducing body which gives the copper and fermentation tests for sugar, but is not sugar.

Acidum Oleicum.—Oleic Acid. Hydrogen Oleate. $CH_3(CH_2)_7CH{:}CH(CH_2)_7COOH$. *Source.*—Obtained by the saponifying action of alkalis and subsequent action of acids, or by the action of superheated steam, upon the olein of fats Usually not quite pure. *See* page 338.

Characters.—A straw-coloured liquid; odour occasionally faintly rancid; and with only a very faint acid reaction. Exposed to air it becomes brown and more acid. Sp. gr. ·890 to ·910. It becomes semisolid at 40° to 41° F. *Solubility.*—Insoluble in water; readily soluble in alcohol, chloroform, and ether. *Impurities.*—Stearic and palmitic acids, giving with lead acetate a precipitate insoluble in ether.

Preparation.

Hydrargyri Oleas.—*See* page 97.

Oleic Acid is also contained in Unguenta Aconitinæ, Atropinæ, Cocainæ, and Veratrinæ. Emplastrum Plumbi contains Lead Oleate (page 65); and Unguentum Zinci Oleatis contains Zinc Oleate (page 75).

ACTIONS AND USES.

Oleic Acid **penetrates the skin** more readily and thoroughly than fixed oils or fats, entering the cutaneous tissues not through the vessels, but through the natural openings, by which it reaches the follicles. It is therefore employed as a solvent and vehicle of active remedies, including alkaloids, for application to the skin, in the form of Oleates, a number of which are now employed.

LOGANIACEÆ.

Nux Vomica.—Nux Vomica.—The seeds of Strychnos Nux-vomica.

Characters.—Nearly disc-shaped, ash- or greenish-grey seeds, ¾ to 1 inch in diameter, ¼ inch thick, concavo-convex, nearly flat, or sometimes irregularly bent, rounded or somewhat acute at the margin, from a small prominence on which a raised line passes to the central hilum. Surface covered with short, satiny, radiately arranged, closely appressed hairs. Endosperm large and horny; cotyledons small and leafy. No odour; taste extremely bitter.

Composition.—Nux Vomica seeds contain two alkaloids: ·2 to ·5 per cent. of *strychnine*, which is official, and ·12 to 1·0

per cent. of *brucine*, united with a crystalline acid, *strychnic* or *igasuric acid*.

Brucine, $C_{23}H_{26}N_2O_4$, occurs in colourless prisms, pearly flakes, or masses. It is soluble in alcohol, much more soluble in water; less bitter, 38 times weaker, and 3 times slower physiologically, than Strychnine. It gives a red colour with HNO_3.

Preparations.

Extractum Nucis Vomicæ Liquidum.—Alcoholic. *Standardised* to contain 1·5 gr. of Strychnine in 110 min. *Dose*, 1 to 3 min.

From Extractum Nucis Vomicæ Liquidum are prepared:

a. Extractum Nucis Vomicæ.—Made by evaporating the Liquid Extract and adding Milk Sugar. *Standardised* to contain 5 per cent. of Strychnine. *Dose*, $\frac{1}{4}$ to 1 gr.

b. Tinctura Nucis Vomicæ.—Liquid Extract, 10; Water, 15; Alcohol 90 per cent., to make 60. Contains $\frac{1}{4}$ gr. Strychnine in 110 min. *Dose*, 5 to 15 min.

From Nux Vomica are made:

1. Strychnina.—Strychnine. $C_{21}H_{22}N_2O_2$.

Source.—Obtained from Nux Vomica and from other species of Strychnos.

Characters and tests.—Trimetric prisms; colourless and inodorous. *Solubility.*—Very sparingly in water, but communicating to it an intensely bitter taste; 1 in 150 of cold, but in less of boiling, alcohol 90 per cent.; slightly in cold absolute alcohol; readily in 40 parts of boiling absolute alcohol; 1 in 6 of chloroform; nearly insoluble in ether. Sulphuric acid forms with it a colourless solution, which on the addition of potassium bichromate acquires an intensely violet hue, speedily passing through red to yellow. When sulphuric acid containing $\frac{1}{2000}$ part of potassium permanganate is brought into contact with a minute particle of strychnine, a violet coloration results.

Impurities.—Brucine; mineral matter.

Dose, $\frac{1}{60}$ to $\frac{1}{15}$ gr. (best given in solution).

Preparation.

Syrupus Ferri Phosphatis cum Quinina et Strychnina.—$\frac{1}{32}$ gr. Strychnine in 1 fl.dr. *See* page 85.

2. Strychninæ Hydrochloridum.—STRYCHNINE HYDROCHLORIDE. $C_{21}H_{22}N_2O_2,HCl,2H_2O$.

Source.—The hydrochloride of an alkaloid obtained from Nux Vomica and from other species of Strychnos.

Characters.—Small, colourless, trimetric prisms, which readily effloresce in the air. *Solubility.*—1 in 35 of water, 1 in 60 of alcohol 90 per cent., forming a solution which is neutral to litmus and intensely bitter to the taste. *Impurities.*—Sulphates. *Dose*, $\frac{1}{60}$ to $\frac{1}{15}$ gr.

Preparation.

Liquor Strychninæ Hydrochloridi.—1; Alcohol, 90 per cent., 25; Distilled Water, to make 100. 1 gr. Strychnine Hydrochloride in 110 min. *Dose*, 2 to 8 min.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Strychnine is a powerful antiseptic, but is too poisonous to be applied to wounds. Brucine is anæsthetic.

Internally.—Nux Vomica and Strychnine possess all the properties of **bitters** described under *Calumba* (p. 219). The use of them is not different from that of other bitters, excepting that whilst unpleasant from the intensity and persistency of their taste and the absence of flavour, they are very convenient on account of their small bulk.

Strychnine is believed to **increase the peristaltic action** of the intestines, and is given with purgatives, especially Aloes, in chronic constipation from atony of the bowels.

2. ACTIONS ON THE BLOOD.

Strychnine enters the blood from mucous surfaces, or when given hypodermically. Here it affects both the red corpuscles and the plasma, reducing the absorptive power of the former for oxygen, and the discharge of carbonic acid from the latter. These effects are not, however, the cause of the specific actions of the drug immediately to be described.

3. SPECIFIC ACTIONS.

Strychnine quickly finds its way into the viscera, especially the nervous system; and is peculiar in remaining so long within them that it is not wholly excreted for several days. It

therefore accumulates in the body if the dose, however small, be very frequently repeated, and is said to have a "cumulative action." Some persons are very susceptible to this drug.

In medicinal doses Strychnine produces a **tonic** influence, as described under Calumba and Quinine, with a sense of increased strength and spirits. Therewith its specific actions are soon developed, namely, first, increased sensibility of touch, sight, and hearing, with some disorder of the senses, such as of colour vision and smell. Repeated or larger doses next lead to sudden twitchings of the muscles of the limbs, a constricted feeling in the chest and some dysphagia, with a sense of anxiety. Poisonous doses produce **violent convulsions** and rapid death by exhaustion and asphyxia from spasmodic arrest of the respiratory muscles. The phenomena resemble tetanus, but differ from it in the complete relaxation of the muscles between the convulsive seizures, in the great rapidity of their course, and in the comparative absence of trismus (lock-jaw).

Careful analysis resolves the phenomena of Strychnine poisoning as follows, and enables us to understand its action in medicinal doses:—The *convolutions* are unaffected. The **motor centres of the cord are powerfully irritated** by toxic doses, and this in such a way that their **reflex excitability is enormously increased.** The very slightest stimulation of the skin such as a breath of air, a loud sound or a bright light is sufficient to originate reflex muscular spasms. The muscles of respiration are manifestly involved in this effect, and the vigour of their action is greatly increased; and this is carried so far that their contraction in inspiration remains, and gives rise to asphyxia.

The *medulla* is stimulated by Strychnine in all its important centres. The **respiratory centre is increased in activity**, and transmits powerful impulses downwards to the already excited cord, thus causing increased frequency and depth of the movements of the chest. **The cardiac centre and the cardiac ganglia and nerves appear to be stimulated** by Strychnine; but the violent contractions of the voluntary muscles completely modify the direct effect of the alkaloid, which is said actually to cause slowing of the heart (in animals paralysed by curare). Death does not occur through the heart, which beats after respiratory death and remains contracted. The *vaso-motor* centre is increased in vigour, an effect which is heightened by the muscular spasm, and finally by the asphyxial state of the blood: thus the pressure rises enormously for a time.

The *motor nerves and muscles* are comparatively unaffected

by Strychnine; but its local application in moderate doses stimulates them, and the same may be said of the *sensory nerves*, vision being improved by injections of Strychnine in the temple, which appears to cause contraction of the retinal cones. The *body temperature* naturally rises during the convulsions.

4. SPECIFIC USES.

Strychnine is indicated in paralysis, especially paralysis from disease or disorder of the cord, but is not of much real service in this class of cases. Its function in cerebral disease is mainly to sustain the activity of the spinal centres, nerves, and muscles until the higher centres are restored; but electricity has in a measure displaced it for this purpose. It appears, however, to be remedial in so-called "reflex" or "functional" paralysis; in diphtheritic paralysis; and in peripheral paralysis (of the fore-arm, eyes, larynx, sphincters, etc.), often toxic in origin, *e.g.* due to lead, tobacco or alcohol. For these local cases Strychnine may sometimes be given in the form of hypodermic or intramuscular injections. In sensory paralysis Strychnine is useless, but it appears to relieve some forms of blindness (amaurosis) when applied locally, *i.e.* hypodermically in the temple. In chronic nervous disorders, such as chorea, epilepsy, neuralgia, alcoholism, insomnia and asthma, it is of benefit as a bitter stomachic and tonic, an effect more generally available than the specific actions of the drug.

As a respiratory stimulant, strychnine is used with great benefit in bronchitis, emphysema and pneumonia, to increase the vigour both of the respiratory centre and the respiratory movements. It is advantageously combined with expectorants, its tonic action being further useful; but in acute cases hypodermic injection is the best method of administration. From its stimulant and tonic actions on the heart and vessels, it is invaluable in cardiac failure, given either internally or hypodermically (1 to 3 min. of the Liquor).

Strychnine is a physiological antagonist of Chloral Hydrate, Morphine and Physostigmine, and may be given both in poisoning by these substances (whilst all the ordinary methods of recovery are persevered in) and to correct their unfavourable effects as remedies.

5. REMOTE LOCAL ACTIONS.

Strychnine is excreted in the urine, sweat and saliva, as we have seen, very slowly. The practical importance of this fact has already been insisted on.

Gelsemii Radix.—Yellow Jasmine. The dried rhizome and roots of Gelsemium nitidum.

Characters.—In nearly cylindrical pieces, 6 inches or more long, ¼ to ¾ inch thick; occasionally with fibrous roots attached. Fracture splintery. The transverse section exhibits a thin cortex and a porous yellowish wood, rendered distinctly radiate by the presence of numerous conspicuous straight medullary rays. The rhizome has usually a brown or dark brownish-violet cork, often much fissured; is nearly straight, and exhibits silky fibres in the bast. The root is yellowish-brown, finely wrinkled and somewhat tortuous. Odour slightly aromatic; taste bitter.

Composition.—Gelsemium contains *gelseminine*, a powerful alkaloid, *gelsemine*, *gelseminic acid*, a *volatile oil*, and other ingredients. *Dose*, 5 to 15 gr.

Preparation.

Tinctura Gelsemii.—1 in 10 of Alcohol 60 per cent.; by percolation. *Dose*, 5 to 15 min.

ACTIONS AND USES.

Gelsemium is a **powerful depressant** of the motor parts of the cord, causing paralysis, which is followed later by sensory depression and anæsthesia. The pupil is dilated if the drug be applied locally; but it is contracted by gelsemium internally administered, and the ocular and levator palpebræ muscles are paralysed, all through the third nerve. Respiration fails, and death occurs by asphyxia. The heart is also depressed. The skin is stimulated.

Gelsemium has been given in tetanus, asthma, whooping cough and other convulsive diseases, with uncertain results. It appears to relieve some cases of facial neuralgia. In sick headache (megrim) it may produce great relief if the dose be cautiously pushed.

APOCYNACEÆ.

Strophanthi Semina.—Strophanthus Seeds. The dried ripe seeds of Strophanthus Kombé, freed from the awns.

Characters.—Oval acuminate seeds, about ⅗ inch long and ⅛ inch broad, greenish-fawn, covered with silky appressed

hairs, flattened, narrowed towards the base which is obtuse, with a longitudinal ridge on one side running from the centre to the apex of the seed. Nucleus white, oily; cotyledons straight, surrounded by a thin endosperm. Sulphuric Acid colours the latter, and sometimes the cotyledons, dark green (presence of strophanthin). Odour characteristic; taste very bitter.

Composition.—The active principle is a glucoside, *strophanthin*, $C_{31}H_{41}O_{21}$, crystalline, very bitter, neutral, very soluble in water, less so in spirit; it gives a dark green colour with Sulphuric Acid. Other constituents are *kombic acid*, *onabaïne*, *inulin*, fat and colouring matter. (*Dose of Strophanthin*, $\frac{1}{300}$ to $\frac{1}{100}$ gr. hypodermically.)

Preparations.

1. **Extractum Strophanthi.**—**1 in 2.** Prepared by percolating the dried seeds first with ether and then with alcohol, evaporating, and adding Milk Sugar. *Dose*, $\frac{1}{4}$ to 1 gr.

2. **Tinctura Strophanthi.**—1 in 40 of Alcohol 70 per cent.; by percolation. *Dose*, 5 to 15 min.

ACTIONS AND USES.

Strophanthus is closely allied to Digitalis in its action on the heart (*see* page 365), but does not affect the arterioles directly. It is extensively used as a **cardiac stimulant and diuretic** in the same class of cases. It is a powerful and valuable remedy, which may be employed in cases of heart disease where digitalis fails or disagrees.

ASCLEPIADACEÆ.

Hemidesmi Radix.—Hemidesmus Root. The dried root of Hemidesmus indicus.

Characters.—Long, rigid, nearly cylindrical, tortuous, and longitudinally furrowed; seldom exceeds $\frac{1}{4}$ inch in thickness; reddish or dark-brown. On one side of the root the cork is frequently separated from and raised above the cortex, and is transversely fissured. Odour fragrant; taste somewhat sweet. *Substances resembling Hemidesmus:* Sarsaparilla, Ipecacuanha, Senega. Hemidesmus has cracks.

Composition.—Hemidesmus contains *hemidesmine* and *tannic acid.*

Preparation.

Syrupus Hemidesmi.—4 in 42. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

Hemidesmus is used in India in lieu of Sarsaparilla. The same obscurity exists respecting the actions and value of this as of the other drug. See *Sarsæ Radix*, page 411.

GENTIANACEÆ.

Gentianæ Radix.—Gentian Root. The dried rhizome and roots of Gentiana lutea.

Characters.—In nearly cylindrical pieces, entire or longitudinally split, varying in length, but seldom exceeding 1 in. in thickness, yellowish-brown externally, longitudinally wrinkled. It also bears closely approximated encircling leaf scars, and is frequently terminated by a bud. Tough when slightly moist; brittle when dried. Fracture nearly uniform reddish yellow. Neither wood nor cortex yields the characteristic reactions with the tests for starch. Odour characteristic; taste at first slightly sweet, afterwards bitter.

Composition.—Gentian contains ·1 per cent. of a bitter glucoside, *gentiopicrin*, $C_{20}H_{30}O_{12}$, crystalline, readily soluble in water and dilute alcohol, yielding by decomposition glucose and *gentiogenin*. This is united with an inert non-bitter body, *gentianic acid*, *sugar*, *gum*, and a trace of a *volatile oil*. *Incompatibles.*—Iron Sulphate, Silver Nitrate, and Lead Salts.

Preparations.

1. **Extractum Gentianæ.**—Aqueous. *Dose*, 2 to 8 gr.

2. **Infusum Gentianæ Compositum.**—1; Dried Bitter-Orange Peel, 1; Fresh Lemon Peel, 2; boiling Water, 80. *Dose*, ½ to 1 fl.oz.

3. **Tinctura Gentianæ Composita.**—10; Dried Bitter-Orange Peel, 3·75; Cardamom Seeds, 1·25; Alcohol 45 per cent., to make 100. By maceration. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

Gentian possesses the actions of **bitters**, as described under *Calumbæ Radix* (page 219). The uses made of it correspond. It is perhaps the most extensively used and most popular of all bitters, because (1) it is agreeable, being very slightly **aromatic**; (2) its bitter is not intense, and its astringency but slight; and (3) it is more stimulant to the bowels, and more disinfectant than some bitters. A drawback to its usefulness is the liability of the sugar which it contains to ferment in simple infusions.

Chirata. — CHIRETTA. The dried plant, Swertia Chirata. Collected in Northern India when in flower.

Characters.—Stem 3 ft. or more long, smooth, brown or purplish-brown, slightly winged and much branched above, rounded below, containing a large, continuous, easily separable pith. Branches slender, elongated, decussate. Leaves opposite, ovate, glabrous, entire, usually with 3 to 7 lateral veins. Flowers small, numerous, panicled. Fruits superior, bicarpellary, unilocular. No odour; taste extremely bitter. *Impurity.*—Munjeet (Rubia cordifolia); without pith and the leaves petiolate. *Substance resembling Chiretta:* Lobelia; not bitter.

Composition.—Chiretta contains an active bitter principle *chiratin*, combined with *ophelic acid*; and no tannic acid.

Preparations.

1. **Infusum Chiratæ.**—1 in 20 of boiling Water. *Dose*, ½ to 1 fl.oz.

2. **Liquor Chiratæ Concentratus.**—Alcoholic. 1 in 2. *Dose*, ½ to 1 fl.dr.

3. **Tinctura Chiratæ.**—1 in 10 of Alcohol 60 per cent.; by percolation. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

Chiretta is an **aromatic bitter**, very similar in its action and uses to Gentian; but may be given with Iron.

CONVOLVULACEÆ.

Scammoniæ Radix.—SCAMMONY ROOT. The dried root of Convolvulus Scammonia.

Characters. — Brownish or yellowish-grey, tapering or nearly cylindrical roots, from 1 to 3 inches or more in diameter, contorted; the surface longitudinally furrowed. It is enlarged at the crown, and bears the remains of slender aërial stems. Fracture very coarsely fibrous; internally the colour is light or dark grey. Odour characteristic; taste at first somewhat sweet, afterwards slightly acrid. It yields to alcohol (90 per cent.) a resin having the properties of Scammony Resin. *Substance resembling Scammony Root:* Belladonna Root, which is smaller.

Scammonium. — SCAMMONY. Virgin Scammony. A gum-resin, obtained by incision from the living root of Convolvulus Scammonia.

Characters.—In flattened cakes or irregular pieces of varying sizes, brown, dark grey or nearly black externally; sometimes covered with a greyish-white powder, very brittle, the freshly exposed surface glossy, resinous, porous, uniformly dark brown or nearly black; in thin fragments the drug is brown and more or less translucent. It is easily reduced to an ash-grey powder, and forms an emulsion with water. Odour characteristic; taste acrid. *Impurities.*—Chalk and starch.

Composition.—Scammony contains 70 per cent. of the official *resin*, and 10 to 20 of *gum*. The root, the gum-resin, and the resin contain an active glucoside, *scammonin*, $C_{34}H_{56}O_{16}$, identical with convolvulin. See *Jalap*, page 350. *Dose*, 5 to 10 gr.

From Scammoniæ Radix is made:

Scammoniæ Resina.—SCAMMONY RESIN.

Source.—Made from Scammony Root by preparing a tincture, precipitating this in water, washing and drying.

Characters.—Brownish translucent pieces, brittle, resinous in fracture, of a sweet fragrant odour. Soluble in ether. Does not, alone, form an emulsion with water. *Impurities.*—Guaiacum Resin, giving blue with potato, with solution of ferric chloride, or with solution of hydrogen peroxide; Jalap Resin, insoluble in ether. *Dose*, 3 to 8 gr.

Preparations.

1. **Pilula Scammonii Composita.**—1; Jalap Resin, 1; Curd Soap, 1; Tincture of Ginger, 3.

This is the only aperient pill in the vegetable materia medica that does not contain Aloes. *Dose*, 4 to 8 gr.

2. **Pulvis Scammonii Compositus.**—4; Jalap, 3; Ginger, 1. *Dose*, 10 to 20 gr.

Scammoniæ Resina is also an important ingredient of: Extractum Colocynthidis Compositum, Pilula Colocynthidis Composita, and Pilula Colocynthidis et Hyoscyami.

ACTIONS AND USES.

Preparations of Scammony are powerful **stimulants of the intestinal glands, and** to a less degree of the **liver,** causing free purgation within a few hours, attended by griping. Scammony begins to act in the duodenum on meeting the bile, and will not purge if injected into the blood.

Scammony is used chiefly as a smart **purgative and anthelmintic** in children, in cases unattended with irritation of the stomach and bowels. As a hydragogue, Jalap is preferred.

Jalapa.—JALAP. The dried tubercules of Ipomœa purga.

Characters.—Dark brown, irregularly oblong, ovoid, napiform or fusiform roots, from 1 to 3 inches or more long, the larger being frequently incised; hard, compact, and heavy; externally furrowed, wrinkled, and marked with transverse scars; internally yellowish-grey or dingy brown. The transverse section usually exhibits irregular dark concentric lines. Odour characteristic; taste at first sweet, afterwards acrid and disagreeable.

Composition.—Jalap should yield 9 to 11 per cent. of the official *resin.* This is composed of two glucosides, *convolvulin*, $C_{34}H_{56}O_{16}$, and *jalapin*, $C_{31}H_{50}O_{16}$. *Dose*, 5 to 20 gr.

Preparations.

1. **Extractum Jalapæ.**—Alcoholic and aqueous. *Dose*, 2 to 8 gr.

2. **Pulvis Jalapæ Compositus.**—Jalap, 5; Acid Potassium Tartrate, 9; Ginger, 1. *Dose*, 20 to 60 gr.

3. **Tinctura Jalapæ.**—1 in 5 of Alcohol 70 per cent.; by percolation. *Standardised. Dose*, ½ to 1 fl.dr.

Jalap is also an important ingredient of Pulvis Scammonii Compositus.—**3 in 8.**

From Jalapa is made:

Jalapæ Resina.—Jalap Resin

Source.—Made by precipitating a tincture of Jalap in water; washing, and drying.

Characters.—Dark-brown opaque fragments, translucent at the edges; brittle, with a resinous fracture; odour sweetish; taste acrid. *Solubility.*—Readily in alcohol 90 per cent.; insoluble in water and oil of turpentine. *Impurities.*—Resins of Tampico Jalap, scammony and guaiacum. *Substance resembling Jalap Resin:* Aloes, which is bitter. *Dose,* 2 to 5 gr.

Jalap Resin is contained in Pilula Scammonii Composita.

ACTIONS AND USES.

The actions of Jalap closely resemble those of Scammony, but it is less irritant or less likely to gripe. Like it, Jalap does not purge unless in the presence of the duodenal fluids; it is also a powerful **stimulant of the intestinal secretion,** less so of the bile. Small doses produce a laxative effect; large doses act within two hours, causing several watery stools, attended by some pain unless the drug be combined with carminatives.

Jalap is extensively used in the form of the Compound Powder, as a **hydragogue** purgative, to drain off water by the bowel in dropsy, and occasionally as an ordinary smart purgative. The Resin in small doses may be used in laxative pills for habitual constipation. As an **anthelmintic,** Jalap is given in Pulvis Scammonii Compositus. This drug must be avoided when the alimentary canal is inflamed or irritable.

SOLANACEÆ.

Capsici Fructus.—Capsicum Fruit. The dried ripe fruit of Capsicum minimum.

Characters.—Dull orange-red, oblong-conical, obtuse, 2-celled fruits, ½ to ¾ inch long, ¼ inch in diameter; sometimes attached to a 5-toothed inferior calyx, and long, straight, slender peduncle. Pericarp somewhat shrivelled, glabrous, translucent, leathery, containing from 10 to 20 small flat seeds, either loose or attached to a thin reddish dissepiment. Odour characteristic; taste intensely pungent.

Composition.—Capsicum yields an acrid acid substance, *capsaicin*, $C_9H_{14}O_2$; a volatile alkaloid, *capsicine*; an *oleo-resin*; and fatty matter. *Impurities.*—Red lead and other coloured substances. *Dose*, ½ to 1 gr. (in pill).

Preparations.

1. **Tinctura Capsici.**—1 in 20 of Alcohol 70 per cent.; by maceration. *Dose*, 5 to 15 min.

2. **Unguentum Capsici.**—12; Spermaceti, 6; Olive Oil, 44.

Tinctura Capsici is an ingredient of Tinctura Chloroformi et Morphinæ Composita.

ACTIONS AND USES.

Externally, Capsicum has a comparatively powerful local action, closely resembling that of volatile oils; and the Ointment may be applied as a **stimulant and counter-irritant.** An ethereal tincture is an excellent preparation in alopecia areata.

Internally, it is used as a **condiment** (cayenne pepper); and medicinally in stimulant gargles, and as a **pungent stomachic, carminative and stimulant,** to dispel flatulence and rouse the appetite, especially in alcoholic subjects.

Belladonnæ Folia.—BELLADONNA LEAVES. The fresh leaves and branches of Atropa Belladonna; collected when the plant is in flower.

Characters.—Leaves alternate below, in unequal pairs above; shortly stalked; 3 to 8 inches long; broadly ovate, acute, entire, nearly glabrous. Corolla gamopetalous, campanulate, of a dingy purple colour. The expressed juice, or an infusion, dropped into the eye, dilates the pupil.

Substances resembling Belladonna Leaves: Stramonium Leaves, more wrinkled; Hyoscyamus Leaves, which are hairy.

Belladonnæ Radix.—BELLADONNA ROOT. The root of Atropa Belladonna; collected in the autumn and dried.

Characters.—In nearly cylindrical pieces, entire or longitudinally split, varying in diameter from ⅛ to ¾ inch, and

from 6 to 12 inches or more in length; externally pale greyish-brown; finely wrinkled longitudinally. Fracture short. Internally whitish and starchy. Within, mostly near to the cambium ring, numerous scattered groups of vessels and fibres, which do not exhibit a prominently radiate arrangement. *Substances resembling Belladonna Root:* Pyrethrum and Scammony Root, *q.v.*

Composition.—Belladonna Leaves and Root contain two alkaloids: (1) ·06 to ·3 per cent. of the official *atropine;* and (2) *belladonnine, homologous* with atropine, and probably *identical* with hyoscyamine, daturine and duboisine. These alkaloids exist as malates in the plant.

Preparations.

A. *Of Belladonnæ Folia:*

1. **Extractum Belladonnæ Viride.**—A *green* extract (*see* page 14). *Dose*, ¼ to 1 gr.

2. **Succus Belladonnæ.**—Juice, 3; Alcohol 90 per cent., 1. *Dose*, 5 to 15 min.

B. *Of Belladonnæ Radix:*

Extractum Belladonnæ Liquidum.—Aqueous and Alcoholic. *Standardised* to contain ¾ gr. of alkaloids in 110 min.

From the Liquid Extract of Belladonna is prepared:

a. **Extractum Belladonnæ Alcoholicum.**—The Liquid Extract evaporated, and Milk Sugar added. *Standardised* to contain 1 per cent. of alkaloids. *Dose*, ¼ to 1 gr.

From the Alcoholic Extract are prepared:

Suppositoria Belladonnæ. — 1½ gr.; Oil of Theobroma, to make 15 gr. $\frac{1}{60}$ gr. of alkaloids in each.

b. **Emplastrum Belladonnæ.**—Liquid Extract, 4, evaporated to 1; Resin Plaster, 5. Contains 0·5 per cent. of alkaloids.

c. **Linimentum Belladonnæ.**—Liquid Extract, 10; Camphor, 1; Distilled Water, 2; Alcohol 90 per cent., to make 20. ·38 per cent. of alkaloids.

d. **Tinctura Belladonnæ.**—Liquid Extract, 1; Alcohol 60 per cent., to make 15. *Standardised*

to contain about ·05 per cent. of alkaloids. *Dose*, 5 to 15 min.

e. **Unguentum Belladonnæ.**—Liquid Extract, 2; Benzoated Lard, 2 ·25. Contains ·6 per cent. of alkaloids.

From Belladonnæ Folia or Radix is made:

Atropina.—Atropine. $C_{17}H_{23}NO_3$.

Source.—Obtained from Belladonna Leaves or Root.

Characters.—Colourless acicular crystals. *Solubility.*—1 in 300 of water; readily in alcohol 90 per cent. and in chloroform and ether. Readily decomposed in solution. Its aqueous solution is alkaline, bitter; powerfully dilates the pupil; and yields with solution of auric chloride a citron-yellow precipitate, which when recrystallised from boiling water acidulated with hydrochloric acid has a minutely crystalline character, and when dry a dull pulverulent appearance (distinction from hyoscyamine). It can be chemically resolved into *tropine*, $C_8H_{15}NO$, and *tropic acid*, $C_9H_{10}O_3$; and reconstructed by the synthesis of these bodies. The intimate cause of the isomerism but non-identity of Atropine with the other alkaloids of the Atropaceæ has yet to be discovered. *Incompatibles.*—Caustic alkalis decompose it. Morphine, Physostigmine and Strychnine are in various respects and degrees physiological antagonists. See *Opium*, page 239, and *Physostigma*, page 275, *Dose*, $\frac{1}{200}$ to $\frac{1}{100}$ gr.

Preparation.

Unguentum Atropinæ.—1; dissolved in Oleic Acid, 4; with Lard, 45.

From Atropina is made:

Atropinæ Sulphas.—Atropine Sulphate. *Source.*—Obtained by neutralising Atropine with Diluted Sulphuric Acid. *Characters.*—Nearly colourless, crystalline. *Solubility.*—1 in 1 of cold water; 1 in 10 of alcohol 90 per cent.; insoluble in ether and chloroform. Solution neutral. *Dose*, $\frac{1}{200}$ to $\frac{1}{100}$ gr.

Preparations.

1. LIQUOR ATROPINÆ SULPHATIS. — 1; Salicylic Acid, ·12; Distilled Water, to make 100. 1 gr. in 110 min. *Dose*, ½ to 1 min.

2. Lamellæ Atropinæ.—Discs of Gelatin, with some Glycerin, each weighing about $\frac{1}{50}$ gr., and containing $\frac{1}{5000}$ gr. of Atropine Sulphate.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.— Belladonna and Atropine, as such or in aqueous suspension or solution, are not absorbed by the unbroken skin; but alcohol, chloroform, camphor or glycerin, with which they are generally combined, readily conveys the Atropine through the epidermis. Exposed mucous membranes and inflamed areas of skin still more readily absorb the alkaloid.

Belladonna depresses the sensory nerve-endings, thus acting as a **local anæsthetic and anodyne**; the blood-vessels are first somewhat contracted, and then relaxed; and the motor-nerve filaments to underlying muscles are reduced in activity. Any other special nerve-endings with which the Atropine may come in contact are similarly depressed, *e.g.* the nerves of the sudoriparous and mammary glands

Belladonna is used locally in Liniment, Plaster or Ointment, and Atropine more rarely in Ointment, to relieve the pain and spasm of muscular rheumatism, and of neuralgia (less useful); as an anodyne and antiphlogistic in acute gout, boils, erysipelas and some kinds of phlebitis, in all of which a Glycerin of Belladonna, or a Glycerin or Flexible Collodion of Atropine, freely applied, is of great service, although it sometimes produces eczema; in pruritus and certain skin diseases, to relieve itching; and as an anti-galactagogue.

Internally.—The action of Belladonna on the mouth is not a local but a specific one, to be presently described. In the stomach it produces a slightly anodyne effect, and has been used to relieve some forms of gastralgia and sickness. Its action on the bowels is also specific, as will be seen.

2. ACTIONS IN THE BLOOD.

Atropine very rapidly enters the blood as such, and leaves it for the tissues. It does not alter the corpuscles.

3. SPECIFIC ACTIONS.

Atropine reaches the organs with remarkable rapidity, and sets up a train of characteristic phenomena. After moderate doses of an efficient preparation of Belladonna, patients complain of dryness in the throat with difficulty of swallowing; the pupils are dilated and vision is confused; possibly the

bowels are relaxed; the pulse is reduced in frequency, the conjunctivæ and face are flushed; the balance and gait may be uncertain. Larger doses aggravate these phenomena, but the pulse now becomes frequent instead of the reverse; restlessness or even convulsions may occur; and the patient becomes delirious. These symptoms occasionally follow the incautious application of Belladonna to wounds or erupted areas of skin. Physiological analysis of these phenomena yields the following results:

Convolutions.—The **delirium** caused by Belladonna is rarely seen after medicinal doses. It is followed by dulness, somnolence and insensibility, all evidences of cerebral depression.

Spinal cord.—Belladonna acts by no means powerfully on the cord, beyond slightly increasing and afterwards diminishing its reflex irritability.

Medulla.—The three great vital centres are markedly affected. The **respiratory centre is powerfully stimulated** by Belladonna, so that the movements of the chest become more frequent and more deep. This effect is independent of the blood-pressure. Poisonous doses paralyse the same centre. The **cardiac centre is for a time stimulated** and the heart slowed. This is but a small part of the effect on the heart, as will be immediately seen. It is said that the **vaso-motor centre is first stimulated and then depressed** by Belladonna, that is, that the systemic arteries are contracted and the blood-pressure is raised for a time, but that the vessels afterwards are relaxed and the pressure lowered, causing the flushing of the skin. According to other authorities vaso-constriction occurs in certain regions, vaso-dilatation in others —the result of stimulation of the vascular centres.

The irritability of the *motor nerves* is diminished, but not lost, except after large doses. The *voluntary muscles* remain unaffected. The *sensory nerves*, which, as we have seen, are locally depressed, are also depressed specifically. Thus pain is prevented or relieved.

Special efferent nerve terminations.—A markedly depressing action is exerted by Belladonna upon the terminations of certain special motor and secretory nerves in connection with the viscera, or upon the "terminal apparatus" between these fibrils and the active protoplasm.

a. **The endings of the third nerve are paralysed in the sphincter of the pupil and in the ciliary muscle, giving rise to the dilatation of the pupil and the disturbance of accommodation.** The effect on the pupil is purely local in its cause; the muscle itself is also unaffected; possibly the sympathetic is somewhat stimulated. The amount of confusion of vision

produced by the paralysis of accommodation will depend on the normal refraction of the patient's eye, long-sighted persons suffering most. The intra-ocular pressure is not diminished, as is sometimes stated; it is increased even by moderate doses.

b. **The terminations of the chorda tympani in the submaxillary gland are paralysed** by Atropine, the results being an arrest of saliva and the dryness of the mouth and throat already mentioned. The sympathetic remains unaffected, so that the vessels in the gland dilate as usual under stimulation, and the "sympathetic secretion" can be obtained as before. Probably the mucous glands of the mouth are also paralysed.

c. **The ends of the sudoriparous nerves in the sweat glands are depressed** by Atropine, which is the most powerful of all anhidrotics. Therewith the skin is flushed, as we saw; overspread sometimes by a scarlatinoid redness or rash. The temperature rises at first, but afterwards falls.

d. **The lacteal nerve terminations are paralysed,** and the secretion of milk (if present) is arrested.

e. **The ends of the vagus (inhibitory apparatus) in the heart** may be **briefly stimulated** by Atropine, thus increasing its slowing action on the cardiac centre in the medulla, already seen; but they **are quickly paralysed,** the pulse rising in frequency to twice its previous rate after full doses; and this frequency cannot be reduced by faradising the vagus. Therewith *the force of the systole is not reduced after moderate doses.* Very large (poisonous) doses depress the ganglia, and finally even the muscle; and death occurs through cardiac failure, with the ventricle in diastole. The depressor and the accelerator filaments are not affected.

It will be convenient to complete here the account of the action of Belladonna on the circulation. The vaso-motor stimulation noted under the medulla coincides with the cardiac acceleration, and thus the blood-pressure is decidedly raised, the heart emptying itself more frequently into tense vessels. Large doses, however, depress the vaso-motor centre; the peripheral vessels are also directly relaxed; the **pressure falls**; and if this be extreme, it coincides with the paralysis of the cardiac ganglia and muscle, and contributes to the final arrest of the circulation.

f. **The terminations of the vagus in the bronchial walls are paralysed** by Atropine, the tension of the muscular coat of the bronchi is diminished, and the air current is thus facilitated. **The afferent branches of the vagus in the same parts are also paralysed,** the drug thus diminishing sensibility and reflex action, that is, dyspnœa and cough. These

effects are in addition to the stimulation of the respiratory centre already noticed.

g. **The inhibitory branches of the splanchnics in the intestinal walls are depressed** by Atropine, which thus **increases the peristaltic movements,** causes relaxation of the bowels, and has a carminative effect. Possibly the ganglia and plexuses and the muscular coat are also influenced.

h. Atropine **paralyses the secretory fibres of the vagus to the stomach.**

i. Atropine appears to affect the terminations of the nerves of the *urethra, bladder* and *vesiculæ seminales;* but this part of its action is still obscure. Frequent desire and inability to pass water is a symptom of over-doses.

Metabolism and temperature.—Nutritive activity is increased by Belladonna, obviously through the increased circulation and respiration; and most of the solid excretions are increased, as will be seen under the urine. The temperature is correspondingly raised; but it sinks with the failure of the circulation after large doses.

Children are less readily affected by this drug.

4. SPECIFIC USES.

From its sedative effect on the *convolutions*, Belladonna in full doses has been given in the low delirium of fevers, mania and alcoholism, especially if Opium fail. Neither for this purpose nor as a hypnotic can it be said to be in general use. It has also been recommended in such neuroses as epilepsy, chorea and megrim; in some cases it relieves the symptoms of these without effecting a cure.

Belladonna has been given with apparent success in many forms of disease of the *spinal cord*, including paralysis with spasm.

Liquor Atropinæ Sulphatis is extensively instilled into the *eye* as a mydriatic or pupil dilator, for ophthalmoscopic examination, and to prevent or break down adhesions in iritis; also to paralyse accommodation before determining refraction. The routine employment of Atropine in all kinds of eye disease is, however, to be deprecated, as it may sometimes precipitate glaucoma. See *Physostigma*, page 275.

Atropine occasionally relieves the *salivation* of pregnancy and of cerebral disease, but is necessarily uncertain, as the pathology of such cases is often obscure.

Belladonna and Atropine are much used as *anhidrotics*, to check the sweats of phthisis and other hectic conditions. The Extracts are generally ordered, in pill at bedtime, or the Solution of Atropine Sulphate when the case can be watched.

Applied in the form of Plaster, Liniment, or Ointment of Belladonna, or as a lotion of Atropine, this drug is constantly employed as an *anti-galactagogue*, to "dispel the milk" at any period after delivery. It may also arrest mammary inflammation.

Belladonna is a valuable remedy in some cases of disease of the *heart and vessels*, where the indication is to empty the left ventricle quickly and relax the vessels, without diminishing the cardiac force. Such cases cannot be further particularised here, but it may be said that Belladonna is frequently given, either alone or combined with Digitalis, thus securing certain advantages of both drugs, whilst otherwise they may antagonise each other. Belladonna is clinically believed to relieve cardiac pain and palpitation, and is sometimes to be preferred to Opium for this purpose; probably this effect is chiefly an indirect one, referable to more frequent, *i.e.* more sufficient, emptying of the ventricles, with lowering of the vascular tension and prevention of distension of the heart. The Plaster, or the Extracts mixed with Glycerin, applied to the præcordia, the Extracts internally, and Atropine subcutaneously, are trustworthy forms for this purpose. A combination of Morphine and Atropine subcutaneously is especially valuable in cardiac distress. See *Opium: Combinations of Morphine and Atropine*, page 239.

Belladonna is used in diseases of the *respiratory organs*, both for the prevention and for the relief of spasm of the bronchi (asthma), spasmodic cough of any kind, and especially pertussis. It is difficult to overestimate the value of this drug as a sedative to the respiratory nerves, as compared with Opium. The latter also relieves spasm and cough, but tends to paralyse the respiratory centre, and has always to be given with particular care. Whilst Belladonna soothes the afferent and efferent nerves of the bronchi, it strengthens the respiratory centre, and may be given with confidence.

Some forms of chronic *constipation* are relieved by Belladonna, which is usually given as the Alcoholic Extract in combination with Aloes and other purgatives, its carminative effect also being valuable. Fissure of the anus and spasm of the sphincter are benefited by its local use as a suppository.

Belladonna is useful in diseases of the *genito-urinary* organs, such as chordee, spermatorrhœa, some cases of retention of urine, the nocturnal incontinence of children, and all forms of painful spasm of the bladder, as in calculus, cystitis, and prostatitis. It is best given as suppository, or applied to the perinæum.

Belladonna or Atropine may be used in *poisoning by opium*

(*see* page 239), and by calabar bean (*see* page 275). Atropine is given in combination with Morphine to prevent certain unpleasant effects of the latter (*see* page 239).

5. REMOTE LOCAL ACTIONS AND USES.

Atropine is excreted unchanged in the urine, almost immediately on its administration: in 10 to 20 hours the last traces have left the body. It increases the urea, phosphates, sulphates and water, but not the chlorides of the urine; that is, is diuretic. It cannot be said to be much used for this purpose. In flowing over the ureters, bladder and urethra it may again relieve local pain and spasm, as indicated in the last section.

Stramonii Semina.—STRAMONIUM SEEDS. The dried ripe seeds of Datura Stramonium.

Characters.—Dark brown or nearly black seeds, about $\frac{1}{8}$ inch long, reniform in outline, flattened; the surface marked with reticulate depressions and minutely pitted. Embryo curved, embedded in a white, oily albumen. They have no marked odour; taste slightly bitter.

Stramonii Folia.—STRAMONIUM LEAVES.—The dried leaves of Datura Stramonium. Collected from plants in flower, cultivated in Britain.

Characters.—Ovate, petiolate, 4 to 6 in. long, smooth, acuminate, unequal at base; sinuate-dentate margin; minutely wrinkled; dark greyish-green, upper surface the darker. Odour characteristic; taste unpleasant and bitter.

Substances resembling Stramonium Leaves: Belladonna Leaves, less wrinkled; Hyoscyamus Leaves, hairy.

Composition.—Both Seeds and Leaves contain a crystalline alkaloid *daturine*, combined with malic acid. Daturine, $C_{17}H_{23}NO_3$, is either identical with hyoscyamine, which is isomeric but not identical with atropine (see *Belladonna*, page 354); or it is a variable mixture of atropine and hyoscyamine.

Incompatibles.—Caustic alkalis, metallic salts, and mineral acids.

Preparations.

A. *Of Stramonii Semina:*

Extractum Stramonii.—Alcoholic. *Dose*, $\frac{1}{4}$ to 1 gr.

B. *Of Stramonii Folia:*

Tinctura Stramonii.—1 in 5 of Alcohol 45 per cent.; by percolation. *Dose*, 5 to 15 min.

ACTIONS AND USES.

Daturine has **an action almost exactly similar to that of Atropine,** but is more depressant to the nerves of the bronchi. The use of Stramonium is almost confined to the treatment of spasmodic affections of the respiratory organs, such as bronchitis and asthma. The Extract in doses of $\frac{1}{4}$ gr. may be given to prevent or lessen attacks; the smoke of the burning Leaves may be inhaled from cigarettes or fuming powders during the paroxysm.

Hyoscyami Folia.—HYOSCYAMUS LEAVES. Henbane Leaves. The fresh leaves and flowers, with the branches to which they are attached, of Hyoscyamus niger; also the leaves and flowering tops, separated from the branches, and carefully dried. Collected from the flowering *biennial* plants.

Characters.—Leaves of various lengths, seldom exceeding 10 inches; mostly sessile; alternate; exstipulate; triangular-ovate or ovate-oblong, acute; undulated, irregularly toothed, sinuate, or pinnatifid; midrib conspicuous; pale green and glandular-hairy, particularly beneath. Branches subcylindrical, glandular-hairy. The fresh herb has a strong characteristic odour; a bitter and slightly acrid taste. The juice dropped into the eye dilates the pupil. *Substances resembling Hyoscyamus: See* Belladonna and Stramonium.

Composition.—The active principles are (1) *hyoscyamine*, $C_{17}H_{23}NO_3$, a crystalline alkaloid, isomeric but not identical with atropine; and (2) *hyoscine*, a syrupy alkaloid, also isomeric with atropine, and forming salts such as the hydrobromide and hydriodide. See *Stramonii Folia*, and *Belladonnæ Folia*, page 353.

Incompatibles.—Vegetable acids, Silver Nitrate, Lead Acetate, and Liquor Potassæ.

Preparations.

1. **Extractum Hyoscyami Viride.**—A *green* extract from the *fresh* plant (*see* p. 14). *Dose*, 2 to 8 gr.

From the Extract is prepared:

PILULA COLOCYNTHIDIS ET HYOSCYAMI, —1 in 3. *See* page 297.

2. **Succus Hyoscyami.**—3 of *fresh* juice to 1 of Alcohol 90 per cent. *Dose*, ½ to 1 fl.dr.

3. **Tinctura Hyoscyami.**—1, *dried*, in 10 of Alcohol 45 per cent.; by percolation. *Dose*, ½ to 1 fl.dr.

From Hyoscyamus Leaves are made:

1. **Hyoscinæ Hydrobromidum.**—Hyoscine Hydrobromide. Scopolamine Hydrobromide. $C_{17}H_{21}NO_4,HBr,3H_2O$.

Source.—Obtained from Hyoscyamus Leaves, different species of Scopola, and possibly other solanaceous plants.

Characters.—Colourless, transparent rhombic crystals, permanent in the air; odourless; taste acrid, slightly bitter. *Solubility.*—1 in 1 of cold water; 1 in 13 of alcohol 90 per cent.; very slightly soluble in ether or chloroform. Aqueous solution slightly reddens *litmus*. Aqueous solution precipitated by solution of mercuric chloride, solution of iodine, and also by solution of potassium hydroxide, but not by solution of ammonia or solution of potassium bichromate. It forms with auric chloride a crystalline salt having a melting-point of 388·4° F. *Dose*, $\frac{1}{200}$ to $\frac{1}{100}$ gr.

2. **Hyoscyaminæ Sulphas.**—Hyoscyamine Sulphate. $(C_{17}H_{23}NO_3)_2,H_2SO_4,2H_2O$.

Source.—Obtained from Hyoscyamus Leaves and possibly other solanaceous plants.

Characters.—A crystalline powder, deliquescent, odourless, having a bitter acrid taste. *Solubility.*—1 in 0·5 of water; 1 in 2·5 of alcohol 90 per cent.; very slightly in ether or chloroform. Solution in water acidulated with hydrochloric acid yields no precipitate with solution of platinic chloride, but affords with solution of auric chloride a yellow precipitate soluble in boiling water acidulated with hydrochloric acid, and again deposited as the solution cools in brilliant, golden-yellow scales (distinction from atropine). *Dose*, $\frac{1}{200}$ to $\frac{1}{100}$ gr.

ACTIONS AND USES.

These closely agree with the action and uses of Belladonna and Stramonium. The special points to be noted in connection with Hyoscyamus are as follows: (1) The pharmaceutical

preparations of the plant are decidedly weaker in their action and must be given in larger doses. (2) The calmative effect of the atropaceous plants on the convolutions is more rapid and pronounced with Hyoscyamus, which is used in insomnia and maniacal excitement. The result appears to be due to the Hyoscine, which is a powerful cerebral sedative, controlling restlessness and inducing several hours' deep sleep. Hyoscine Hydrobromide is given hypodermically in doses of $\frac{1}{200}$ to $\frac{1}{100}$ gr. or more, particularly for delirium. It is doubtful how far Hyoscyamine possesses this action, and in certain other respects the two alkaloids seem opposed to each other. (3) The laxative and carminative effects on the bowel are decided; and Extract of Hyoscyamus is often combined with more active purgatives in pills. (4) The remote local action on the urinary organs is more marked, and the Tincture is in general use to relieve irritability of the bladder. (5) Hyoscine is sometimes used as a mydriatic.

Homatropinæ Hydrobromidum. — Homatropine Hydrobromide. $C_{16}H_{21}NO_3,HBr$.

Source.—Prepared from tropine.

Characters.—A white crystalline powder or aggregation of minute trimetric crystals. *Solubility.*—1 in 6 of cold water; 1 in 133 of absolute alcohol; solutions neutral. Dilute aqueous solution powerfully dilates the pupil. Treated with fuming nitric acid and potassium hydroxide, no reddish-violet coloration is developed (distinction from atropine), the residue becoming coloured reddish-yellow. *Dose*, $\frac{1}{60}$ to $\frac{1}{30}$ gr.

Preparation.

Lamellæ Homatropinæ.—Discs of Gelatin, with some Glycerin, each weighing about $\frac{1}{60}$ gr., and containing $\frac{1}{100}$ gr. Homatropine Hydrobromide.

ACTIONS AND USES.

The actions of Homatropine are **similar to those of Atropine**, but weaker. It is used only in ophthalmic practice, its advantage being that whilst it acts on the eye as promptly as Atropine, though not so energetically, its effects subside in one-fourth the time.

SCROPHULARIACEÆ.

Digitalis Folia. — DIGITALIS LEAVES. Foxglove Leaves. The leaves of Digitalis purpurea, collected from plants commencing to flower.

Characters.—From 4 to 12 or more inches long, sometimes as much as 5 to 6 inches broad, with a winged petiole; broadly ovate or oval lanceolate, subacute, crenate; or crenate-dentate, somewhat rugose, hairy, dull-green above; densely pubescent, paler beneath. Odour faint; taste very bitter. *Substance resembling Digitalis Leaves:* Matico; more deeply reticulated.

Composition.—The active principle of Digitalis, known as *digitalinum*, or *digitalin*, occurs in two forms: (*a*) *Homolle* and *Quévenne's digitalin*, a yellowish-white, amorphous or scaly, intensely bitter substance; and (*b*) *Nativelle's digitalin*, in crystalline prisms, also very bitter. It is now known to be a compound of four glucosides, namely, (1) *Digitalin* proper, $C_5H_8O_2$, insoluble in water, forming the bulk of Homolle's digitalin; (2) *Digitaleïn*, very soluble in water; (3) *Digitoxin*, $C_{31}H_{33}O_7$, insoluble in water, soluble in alcohol, the most toxic of the four, and the chief constituent of Nativelle's digitalin; and (4) *Digitonin*, $C_{31}H_{52}O_{17}$, probably the same as saponin, the active principle of Senega. *See* page 245.

Incompatibles.—Ferric salts, which give a slightly inky colour with Digitalis (tannates); lead acetate; preparations of cinchona. *Dose of the powdered leaf*, ½ to 2 gr.

Preparations.

1. **Infusum Digitalis.**—1 in 160 of boiling Water. *Dose*, 2 to 4 fl.dr.

2. **Tinctura Digitalis.**—1 in 8 of Alcohol 60 per cent.; by percolation. *Dose*, 5 to 15 min.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, Digitalis has a slightly irritant action; it is probably not absorbed by the unbroken skin.

Internally, in full doses, it deranges the stomach and bowels; dyspepsia, vomiting and occasionally diarrhœa following its continued use. These effects are partly local, partly specific, and to be avoided or checked in practice.

2. ACTIONS IN THE BLOOD; AND SPECIFIC ACTIONS.

The active principles of Digitalis enter the blood freely. Thence they reach the tissues more quickly than they leave them; and doses, however small, tend to *accumulate* in the body if closely repeated. **The action of Digitalis is mainly confined to the circulatory organs,** its effects on other parts being chiefly secondary. Both the heart and vessels are influenced by the drug, the action of which occupies *four stages*, the first stage being shorter, the other stages more marked, as the dose is increased.

In the *first stage* the heart falls in frequency (say to sixty per minute), from stimulation of the vagus in the heart and medulla; and beats with increased force, from stimulation of the muscular tissue. Therewith the arterial pressure rises, both from increased cardiac force, and from direct stimulation of the muscular coat of the arterioles. The result of all this is that the ventricles are well filled (diminished frequency, *i.e.* lengthened diastole); the ventricles are thoroughly emptied (increased force); the arteries are thus well filled; and they are kept filled (vaso-motor action). The condition is that of a perfect circulation, which **empties the veins and fills the arteries.**

The *second stage* begins in about 48 to 60 hours. It is marked by a striking increase in the excretion of urine. This diuretic effect has been referred by some authorities to secondary relaxation of the renal arterioles by the digitaleïn and digitoxin, and consequent increase of the arterial pressure on the glomeruli, the general blood-pressure remaining high; but it may be due simply to the increased rate of blood-flow through the kidneys.

In the *third stage*, the heart rises in frequency from depression of the vagus, and probably some irritation of the sympathetic (accelerator) fibres; and it loses force from commencing exhaustion of the myocardium. At the same time the arterial pressure falls, from the depression of the heart and possibly of the walls of the peripheral arterioles. Thus the **circulation begins to fail.**

In the *fourth stage*, the action of the heart becomes irregular, frequent and weak from inhibitory disturbance and failure of the myocardium; and it is finally arrested in diastole. Therewith syncope, vomiting, diarrhœa and anuria are prominent phenomena. **Death occurs by general circulatory failure.**

Respiration fails at last, but only through the circulation; and the *voluntary muscles*, which are stimulated at first, are paralysed—partly, it may be, through failure of

their blood supply. The *uterus* is said to be stimulated by moderate doses. The *body temperature* is briefly raised through increased vigour of the circulation; it is then lowered by the increased blood-flow in the skin; and falls still more in the last stages, in an irregular uncertain way, from causes still obscure. Digitalis is thus a **refrigerant**. The *central nervous system* is affected, perhaps only secondarily, through the blood supply. Headache, giddiness and disturbances of vision are frequently induced by medicinal doses of Digitalis; with a sense of faintness, depression, nausea or actual sickness. *Metabolism* is variously influenced by Digitalis, according to the length of the different stages and the rapidity of their development. When the pressure and temperature are high, the urea and uric acid may be increased, and certain salts diminished in amount.

The effects of Digitalis on the *urinary water* in the healthy individual are uncertain; the period at which the renal structures begin to be affected, the duration of the second stage, and the relation of the action of the drug on the heart to its action on the vessels, being all variable. As a rule, the amount of urine is not increased in health; but the drug is **a powerful diuretic** in some cases of dropsy to be referred to presently.

3. SPECIFIC USES.

Digitalis is one of the most valuable of medicinal remedies, and is employed in the following conditions:—

Digitalis is indicated in **diseases of the heart**, when the nervo-muscular structures of the cardiac walls fail, so that the circulatory force declines, the cavities are insufficiently emptied, the arteries are incompletely filled, the veins imperfectly drained, and the blood accumulates behind the seat of disease. Such a condition is characterised by cardiac distress or pain; a small, weak, and often irregular pulse; distension of the veins, hæmorrhage, dropsy, and visceral disorder; and often by congestion of the lungs and great dyspnœa. It occurs under a variety of circumstances which demand separate consideration.

The disturbances of the circulation produced by disease of the *valves* of the heart are removed by a natural process of compensation, consisting of hypertrophy of the muscular walls, with or without dilatation of the cavities. If this compensation do not occur, or if it fail after having been established, and the circulation be disordered as described, Digitalis may give relief, by increasing the force of the car-

diac wall; lengthening diastole, so that the venous flow and ventricular rest and anabolism, are all prolonged; and sustaining arterial pressure, thus driving the blood in a steady stream into the veins. All the symptoms are thus removed, including dropsy, the fluid being absorbed and excreted by the kidneys as a profuse diuresis, which sets in about the third day. Mitral disease, tricuspid incompetence, and aortic obstruction are the forms of valvular disease in which imperfect or failing hypertrophy is relieved by Digitalis. It has been maintained that in aortic incompetence the drug is contra-indicated as prolonging diastole and thus permitting longer reflux; but this consideration is not to be abused, and Digitalis may be given in this as in every other form of valvular disease if the ventricle fail. In cases when little more than a tonic effect on the heart is desired, small doses (min. 5) of the Tincture are prescribed. When dropsy is present, and the patient confined to bed, the Tincture in doses of 10 to 15 min. every four hours, the Infusion, or the powdered leaf should be given, and the effect carefully watched. Without nourishing, digestible and digested food Digitalis can only exhaust the heart, and attention must therefore be paid to the stomach, liver and bowels. Iron, and occasionally Quinine, may be combined with advantage, but only after the excretory and digestive functions have been restored. Let it be carefully observed that Digitalis is not to be given in a routine fashion for valvular disease, but *with reference to the state of the muscular wall of the heart associated with the lesion.*

Digitalis is of great service in failure of the heart from *primary* disease of the walls, as in chronic myocarditis; in the granular degeneration of acute myocarditis, pericarditis and endocarditis, occurring in scarlet fever and acute rheumatism; and in acute alcoholism. In fatty degeneration it may have to be withheld, lest irregular contraction and rupture occur. Digitalis restores the vigour of the heart in failing hypertrophy of *chronic Bright's disease*, when it is breaking down against excessive peripheral resistance; until the heart begins to fail, the drug is contra-indicated, but when dilatation sets in, it must be given. In *functional* or *nervous* palpitation, pain or irregularity, with debility and dyspepsia, Digitalis is often valuable, as also in reflex cases with gastric disorder, where small doses control the vagus; but it must be given intermittently, the dyspeptic effect of the drug also being remembered. Digitalis is harmful in pure *hypertrophy*. In disease of the *right ventricle* from chronic bronchitis or pulmonary disease it is also useful. In *exophthalmic goitre* it is very often given, but is of doubtful value. In *cardiac*

dilatation Digitalis is a thoroughly rational and highly successful remedy. In *renal dropsy* it is of great service when this is acute, complicating scarlet fever, or when due to failure of a hypertrophied heart. In dropsy from chronic tubal nephritis (large white kidney) it is rarely of use, as it has no influence on the renal cells.

Digitalis is used in hæmorrhage, but therapeutics is notoriously uncertain here. It will relieve hæmoptysis due to mitral disease, or to the congestion of incipient phthisis with languid circulation. For menorrhagia it may be useful by stimulating the uterine wall, or in the subjects of heart disease.

Digitalis is but little used by English physicians as an antipyretic in fever, as it is slow, uncertain, dangerous and unnecessary. In secondary bronchial catarrh and acute pneumonia it acts chiefly as a cardiac stimulant. Combined with Quinine it is exhibited in phthisis, but is apt to derange digestion. Empirically, in doses of several drachms, the Tincture has been found useful in delirium tremens, but is unquestionably dangerous. Moderate doses are invaluable in the same disease, or in subacute or chronic cases of alcoholism, to stimulate the heart, relieve low sinking feelings, and rouse the appetite.

4. REMOTE LOCAL ACTIONS.

Traces of some of the active principles of Digitalis have been detected in the urine. The action of the drug upon the urine, let it be carefully noted, is due to its influence not on the cells of the kidneys but on the heart and vessels generally.

5. ACTIONS OF THE OTHER CONSTITUENTS OF DIGITALIS.

Digitaleïn appears to possess the properties of a mixture of digitalin and digitonin. Digitoxin is by far (7 times) the most powerful, a local irritant and a muscular depressant; and therefore, and because insoluble, unfit for use. None of the constituents are so suitable as Digitalis Leaf itself.

LABIATÆ.

Oleum Rosmarini.—Oil of Rosemary.

Source.—Distilled from the flowering tops of Rosmarinus officinalis.

Characters.—Colourless or pale yellow; odour of rosemary; taste warm, camphoraceous. Sp. gr. ·900 to ·915. *Solubility.*—1 in 2 of alcohol 90 per cent.

Composition.—Oil of Rosemary consists of a terpene, $C_{10}H_{16}$, and a stearoptene, $C_{10}H_{16}O$. *Impurity.*—Oil of Turpentine. *Dose*, ½ to 3 min.

Preparation.

Spiritus Rosmarini.—1 in 9 of Alcohol 90 per cent.

Oil of Rosemary is also contained in Linimentum Saponis and Tinctura Lavandulæ Composita.

ACTIONS AND USES.

Rosemary resembles the other **aromatic** oils in its actions and uses. It is a favourite component of stimulating lotions.

Oleum Lavandulæ.—Oil of Lavender.

Source.—Distilled from the flowers of Lavandula vera.

Characters.—Nearly colourless or pale yellow, with the fragrant odour of the flowers, and a pungent bitter taste. Sp. gr. not below ·885. *Solubility.*—1 in 4 of alcohol 70 per cent. *Impurities.*—Oils of spike and turpentine.

Composition.—Oil of Lavender is a mixture of a terpene, $C_{10}H_{16}$, and a stearoptene, $C_{10}H_{16}O$. *Dose*, ½ to 3 min.

Preparations.

1. **Spiritus Lavandulæ.**—1 in 9 of Alcohol 90 per cent. *Dose*, 5 to 20 min.

2. **Tinctura Lavandulæ Composita.**—4·7; Oil of Rosemary, ·5; Cinnamon Bark, 8·5; Nutmeg, 8·5; Red Sanders Wood, 17; Alcohol 90 per cent., to make 1000. *Dose*, ½ to 1 fl.dr.

Tinctura Lavandulæ Composita is contained in Liquor Arsenicalis; *Oleum Lavandulæ is also an ingredient of* Linimentum Camphoræ Ammoniatum.

ACTIONS AND USES.

Lavender possesses the actions of **aromatic** volatile oils in general, and is used in the same way. The Tincture is a favourite colouring ingredient of mixtures and lotions.

Oleum Menthæ Piperitæ.—OIL OF PEPPERMINT. *Source.*—Distilled from fresh flowering peppermint, Mentha piperita.

Characters.—Colourless, pale yellow or greenish-yellow, becoming darker by age; with characteristic odour; taste penetrating and aromatic, succeeded by a sense of coldness in the mouth. Sp. gr. ·900 to ·920. *Solubility.*—1 in 5 of alcohol 70 per cent. *Dose*, ½ to 3 min.

Oleum Menthæ Viridis.—OIL OF SPEARMINT. *Source.*—Distilled from fresh flowering spearmint, Mentha viridis.

Characters.—Colourless, pale yellow or greenish-yellow, becoming darker by age; with odour and taste of the herb. Sp. gr. ·920 to ·940. *Solubility.*—1 in ½ each of absolute alcohol and alcohol 90 per cent.

Composition.—Peppermint Oil consists of a terpene, *menthene*, $C_{10}H_{18}$, and the official stearoptene, *menthol* or *peppermint-camphor* (*see* below). Oil of Spearmint has a somewhat similar composition, *carvol*, $C_{10}H_{14}O$, replacing menthol. *Dose*, ½ to 3 min.

Preparations.

A. *Of Oil of Peppermint:*

1. **Aqua Menthæ Piperitæ.**—1 in 1000, by distillation.

2. **Spiritus Menthæ Piperitæ.**—1 in 9 of Alcohol 90 per cent. *Dose*, 5 to 20 min.

Oil of Peppermint is also contained in Pilula Rhei Composita and Tinctura Chloroformi et Morphinæ Composita.

B. *Of Oil of Spearmint:*

Aqua Menthæ Viridis.—1 in 1000, by distillation.

Menthol.—MENTHOL. $C_6H_9{\cdot}OH{\cdot}CH_3{\cdot}C_3H_7$. *Source.*—Obtained by cooling the oil distilled from the fresh herb of Mentha arvensis (vars. piperascens et glabrata), and of Mentha piperita.

Characters.—Colourless acicular crystals, usually moist from adhering oil; or crystalline masses. Has the odour and flavour of peppermint, producing a sensation of warmth on the tongue, and if air is inhaled, a sensation of coolness. Melting-point 107·6° F., not exceeding 109·4° F. *Solubility.*—Sparingly in water; readily in alcohol 90 per cent.; the

solution neutral. Boiled with sulphuric acid diluted with ⅓ volume of water, it acquires an indigo blue or ultramarine colour, the acid becoming brown. *Dose*, ½ to 2 gr.

Preparation.

Emplastrum Menthol. — 3; Yellow Wax, 2; Resin, 15.

ACTIONS AND USES.

Peppermint and Spearmint possess in the main the actions of other **aromatic** oils (see *Caryophyllum*, p. 292), and are used accordingly. They are favourite flavouring agents, with powerful carminative effects. In two important respects, however, Peppermint Oil is peculiar: (1) *locally*, instead of dilatation it causes at first acute contraction of the vessels, leading to a sense of coldness; (2) it appears to diminish instead of increasing the white corpuscles in the blood, by checking the activity of the intestinal absorbents.

Menthol is used locally to relieve the pain of rheumatism, neuralgia, affections of the throat, and toothache, possessing as it does the **local anæsthetic**, vascular stimulant, and disinfectant actions of volatile oils, described under *Oleum Terebinthinæ*, page 401.

Thymol.—THYMOL. $C_6H_3 \cdot OH \cdot CH_3 \cdot C_3H_7$. Purified by recrystallisation from alcohol. *Source.*—Obtained from the volatile oils of Thymus vulgaris, Monarda punctata, and Carum copticum (N.O. Umbelliferæ).

Characters.—Large oblique prisms, having the odour of thyme and a pungent aromatic taste. Volatilised completely at the temperature of a water-bath. *Solubility.*—Almost insoluble in cold water; freely in alcohol 90 per cent., ether, and solutions of alkalis. Solution in half its bulk of glacial acetic acid, warmed with an equal volume of sulphuric acid, assumes a reddish-violet colour. *Dose*, ½ to 2 gr. (in pill).

Non-official Preparations.

(1) THYMOL SOLUTION.—1 in 1000 of warm water.

(2) THYMOL GAUZE.—Contains 1 per cent. of Thymol.

(3) THYMOL OINTMENTS.—From 5 to 30 gr. in 1 oz.

(4) THYMOL INHALATION.

ACTIONS AND USES.

Externally, Thymol is **antiseptic, disinfectant and deodorant,** 1 part in 109 killing developed bacteria. Although it is more active than Phenol, and has the further advantage of a pleasant odour and a less irritant effect on animal tissues, it is not much used in the Listerian system. The solution may be employed as a lotion, injection or spray; an alcoholic and ethereal solution (1 in 15) as an application in ringworm; and the ointments in various diseases of the skin. *Internally*, its action somewhat resembles that of Turpentine. It is a powerful intestinal antiseptic; and in 30-gr. doses, a valuable anthelmintic in ankylostomiasis.

POLYGONACEÆ.

Rhei Radix.—Rhubarb Root. The erect rhizome or so-called root of Rheum palmatum, Rheum officinale, and probably other species, collected in China and Tibet, deprived of more or less of its cortex, and dried.

Characters.—In cylindrical, barrel-shaped, conical, plano-convex or irregularly-formed pieces; surface sometimes covered with a bright yellowish-brown powder; rounded or somewhat angular, usually smooth, and marked, beneath the powder, with reddish-brown or dark rusty-brown lines, intermixed in a yellowish-brown or greyish substance, and nearly always presenting small, scattered starlike marks. Frequently the pieces are bored with a hole which may contain the remains of the cord used to suspend them to dry. Hard, compact; fracture uneven, presenting a marbled appearance, and in some cases a rhomboidal network of reddish lines. Odour characteristic, somewhat aromatic; taste bitter, feebly astringent; when chewed it is gritty between the teeth.

Composition.—Rheum contains 3 to 4 per cent. of *cathartic acid*, the purgative constituent of Senna (*see* page 277). With this is combined *rheo-tannic acid*, which possesses astringency. The yellow colouring matter, *chrysophan*, is bitter (*see* page 277). *Emodin*, *phæretin*, *starch*, *resins*, and *calcium oxalate* (35 per cent.) are less important constituents. *Impurities.*—English Rhubarb, known by taste, odour, and excess of starch. Turmeric, turned brown by boric acid. *Dose*, as a stomachic, 3 to 10 gr. repeated; 15 to 30 gr. at once.

Preparations.

1. **Extractum Rhei.**—Alcoholic; by percolation and evaporation. *Dose*, 2 to 8 gr.

2. **Infusum Rhei.**—1 in 20 of boiling Water. *Dose*, ½ to 1 fl.oz.

3. **Liquor Rhei Concentratus.**—Alcoholic. 1 in 2; by percolation. *Dose*, ½ to 1 fl.dr.

4. **Pilula Rhei Composita.**—60; Socotrine Aloes, 45; Myrrh, 30; Hard Soap, 30; Oil of Peppermint, 3·75; Syrup of Glucose, 55. *Dose*, 4 to 8 gr.

5. **Pulvis Rhei Compositus.**—"Gregory's Powder." 2; Light or Heavy Magnesia, 6; Ginger, 1. *Dose*, 20 to 60 gr.

6. **Syrupus Rhei.**—2; Coriander, 2; Sugar, 24; Alcohol 90 per cent., 8; Water, 24. *Dose*, ½ to 2 fl.dr.

7. **Tinctura Rhei Composita.**—2; Cardamom Seeds, ·25; Coriander Fruit, ·25; Alcohol 60 per cent., 16; Glycerin, 2, or q.s.; by percolation. *Dose*, ½ to 1 fl.dr. repeated; 2 to 4 fl.dr. at once.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

The actions of Rhubarb are confined to the alimentary canal. In small doses (1 to 5 gr.), the bitter principle and rheo-tannic acid are chiefly active, as **bitter stomachics and intestinal astringents.** In larger doses (up to 40 gr.) the cathartic acid exerts its influence before the rheo-tannic acid; **stimulates the intestinal movements and liver,** as in Senna, with some griping; and causes **purgation,** producing in six to eight hours a liquid motion which is of a yellow colour from the pigment of the Rhubarb and excess of bile. Thereafter, the effect of the tannic acid becomes evident, and the bowels are confined.

Rhubarb is used in small doses as a bitter stomachic, intestinal astringent, and tonic, to correct atonic indigestion with diarrhœa, as in dyspeptic, bilious and gouty adults and rickety infants and children. Larger doses are given as a purgative, in the form of the Compound Powder, combined sometimes with a mercurial, to sweep out the bowels, and then set them at rest, in cases of summer diarrhœa, and *diarrhœa ab ingestis* of children. The Compound Pill is a familiar mild laxative for habitual use, suiting some persons but demanding constant repetition in the majority. The cholagogue action of Rhubarb adds to its value both in stomachic and purgative preparations. Its griping effect must be remembered.

2. ACTIONS IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

The chrysophan, at least, is absorbed into the blood, passes through the tissues, and is thrown out in the secretions, including the urine, which it stains yellow.

MYRISTICACEÆ.

Myristica.—NUTMEG. The dried seed of Myristica fragrans, divested of its testa.

Characters.—Oval or rounded; about an inch long; greyish-brown externally, with reticulated furrows; internally greyish-red with brownish-red veins, so that the transverse section is marbled. Odour strong, pleasantly aromatic; taste agreeably aromatic, warm, and somewhat bitter.

Composition.—Nutmeg and mace contain about 30 per cent. of a fixed *concrete oil*, 4 to 9 per cent. of the official *volatile oil*, starch, etc.

Nutmeg is contained in Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Spiritus Armoraciæ Compositus, and Tinctura Lavandulæ Composita.

From Myristica is made:

Oleum Myristicæ.—The oil distilled from Nutmeg. Colourless or pale yellow, having the odour and taste of nutmeg. Sp. gr. ·870 to ·910. *Solubility.*—1 in ½ each of absolute alcohol and alcohol 90 per cent. Consists chiefly of a terpene, *myristicen*, $C_{10}H_{16}$, and *myristicol*, $C_{10}H_{16}O$. *Impurity.*—Concrete oil of nutmeg. *Dose*, ½ to 3 min.

Preparation.

SPIRITUS MYRISTICÆ.—1 in 9 of alcohol 90 per cent.; agitated if necessary with powdered talc, and filtered. *Dose*, 5 to 20 min.

Spiritus Myristicæ is contained in Mistura Ferri Composita.

Oleum Myristicæ is contained in Pilula Aloes Socotrinæ, Spiritus Ammoniæ Aromaticus, Tinctura Guaiaci Ammoniata, and Tinctura Valerianæ Ammoniata.

ACTIONS AND USES.

The Volatile Oil resembles its many aromatic allies. It is chiefly used for culinary purposes. The expressed oil has

locally the **mechanical and stimulant** actions of the fixed and volatile oils, and is used as an inunction or in plasters to relieve the pain and swelling of chronic rheumatism, etc.

LAURACEÆ.

Cinnamomi Cortex.—CINNAMON BARK. The dried inner bark of shoots from the truncated stocks of Cinnamomum zeylanicum, obtained from cultivated trees. Imported from Ceylon, and distinguished in commerce as Ceylon cinnamon.

Characters.—Closely rolled quills, each about $\frac{3}{8}$ inch in diameter, containing smaller quills. It is thin, brittle, splintery, light yellowish-brown externally, with little scars or holes and faint shining wavy lines; darker brown within. Odour fragrant; taste warm, sweet, aromatic. *Impurity.*—Cassia bark; rougher, thicker, less aromatic, starchy.

Composition.—Cinnamon Bark contains the official *volatile oil, tannic acid, sugar,* and *gum.*

Preparations.

1. **Aqua Cinnamomi.**—1 in 10; by distillation.

Aqua Cinnamomi is contained in Mistura Cretæ, Mistura Guaiaci, Mistura Olei Ricini, Mistura Spiritus Vini Gallici, Syrupus Aromaticus, and Syrupus Cascaræ Aromaticus.

2. **Pulvis Cinnamomi Compositus.**—Compound Powder of Cinnamon. Pulvis Aromaticus. 1; Cardamom Seeds, 1; Ginger, 1. *Dose,* 10 to 40 gr.

Pulvis Cinnamomi Compositus is contained in Pilula Aloes et Ferri and Pilula Cambogiæ Composita.

3. **Tinctura Cinnamomi.**—1 in 5 of Alcohol 70 per cent.; by percolation. *Dose,* $\frac{1}{2}$ to 1 fl.dr.

Cinnamon is also contained in Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Pulvis Kino Compositus, Decoctum Hæmatoxyli, Tinctura Cardamomi Composita and Tinctura Lavandulæ Composita.

From Cinnamomi Cortex is made:

Oleum Cinnamomi.—The oil distilled from Cinnamon Bark.

Characters.—Yellow when recent, becoming reddish; odour and taste of Cinnamon Bark. Sp. gr. 1·025 to 1·035.

Composition. — Contains (or yields) cinnamic aldehyde, $C_6H_5 \cdot C_2H_2 \cdot COH$, and cinnamic acid, $C_6H_5 \cdot CH \cdot CH \cdot COOH$, as well as benzoates. See *Storax*, page 391, and *Balsamum Peruvianum*, page 272. *Impurity.*—Cinnamon leaf oil, yielding a pale green (not a decided blue) coloration with ferric chloride solution. *Dose*, ½ to 3 min.

Preparation.

Spiritus Cinnamomi.—1 to 9 of Alcohol 90 per cent. *Dose*, 5 to 20 min.

Spirit of Cinnamon is contained in Acidum Sulphuricum Aromaticum.

ACTIONS AND USES.

Cinnamon, besides possessing the same actions and being used for the same purposes, as other **aromatic** substances (see *Caryophyllum*, page 292), has moderately **astringent** properties in virtue of its tannic acid. It is therefore the favourite flavouring and carminative agent in the official astringent powders, tinctures, etc. These are chiefly used in diarrhœa.

Camphora.—Camphor. $C_{10}H_{16}O$. *Source.*—Obtained from Cinnamomum Camphora, and purified by sublimation.

Characters and Composition.—In solid, colourless, transparent, crystalline pieces of tough consistence; also in rectangular tablets or in pulverulent masses known as "flowers of camphor." Sp. gr. about 0·995. Odour powerful and penetrating; taste pungent, somewhat bitter, followed by a sensation of cold. Burns readily with a bright smoky flame; volatilises even at ordinary temperatures; sublimes without residue when heated. *Solubility.*—1 in about 700 of water; 1 in about 1 of alcohol 90 per cent.; 1 in ¼ of chloroform; 1 in 4 of olive oil; very soluble in ether. Forms a liquid when triturated with chloral hydrate, menthol, phenol, or thymol. Borneo Camphor, sometimes substituted for Japan Camphor, is obtained from Dryobalanops aromatica; has the formula $C_{10}H_{18}O$, *i.e.* bears the same relation to it as alcohol to aldehyde; and sinks in water. *Dose*, 2 to 5 gr.

Preparations.

1. Aqua Camphoræ.—About 1 in 1000 by solution with the aid of alcohol 90 per cent.

2. **Linimentum Camphoræ.**—"Camphorated Oil." 1 to 4 of Olive Oil.

3. **Linimentum Camphoræ Ammoniatum.**—20; Strong Solution of Ammonia, 40; Alcohol 90 per cent., 99; Oil of Lavender, 1.

4. **Spiritus Camphoræ.**—1 to 9 of Alcohol 90 per cent. *Dose*, 5 to 20 min. (in milk or on sugar).

5. **Tinctura Camphoræ Composita.** — Paregoric Elixir. Paregoric. 3·4; Tincture of Opium, 60·9; Benzoic Acid, 4·6; Oil of Anise, 3·1; Alcohol 60 per cent., to make 1000. 1 fl.dr. contains $\frac{1}{30}$ gr. of Morphine Hydrochloride or $\frac{1}{4}$ gr. of Opium. *Dose*, 30 to 60 min.

Camphor is also contained in Linimenta Aconiti, Belladonnæ, Chloroformi, Hydrargyri, Opii, Saponis, Sinapis, Terebinthinæ, and Terebinthinæ Aceticum; and in Unguentum Hydrargyri Compositum.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Camphor closely resembles in its actions the volatile oils as described under *Oleum Terebinthinæ* (p. 401). It is (1) weakly **antiseptic**; (2) **stimulating to the local circulation**; and (3) **sedative to the nerves after preliminary stimulation.** The uses of Camphor externally depend on these properties: the many liniments and ointments which contain it are intended to increase the nutrition of indurated or stiffened parts, to produce counter-irritation or to relieve pain. The compounds with Phenol, Chloral Hydrate and Thymol are anodynes.

Internally.—Camphor combined with Phenol forms an antiseptic and anæsthetic dressing for carious teeth. On the tongue it produces a peculiar taste, increase of the local circulation, salivation and mucous flow. Reaching the stomach, it causes a sense of warmth; it is a weak antiseptic; and again acts like Turpentine. Briefly, it is a **carminative**: its purely local action stimulating digestion and relieving flatulence, and its reflex effects being visible in increased action of the heart, in fulness and force of the pulse, and in cerebro-spinal excitation. Its carminative properties, whilst generally applicable, are specially valuable in hysterical vomiting.

The intestinal effects of Camphor are similar, and it is therefore useful in some forms of diarrhœa, in the first stage of cholera and in meteorism.

2. ACTIONS ON THE BLOOD.

Camphor enters the blood freely from the unbroken skin and mucous surfaces, and is found in it unchanged. The leucocytes markedly increase in number, apparently from the stimulation of the abdominal circulation.

3. SPECIFIC ACTIONS AND USES.

In the organs and tissues a portion of the Camphor administered is found unchanged; the rest appears to combine with glucose. The nervous system is chiefly affected by this drug, which in doses above those usually ordered may so act on the cerebrum as to produce a kind of **intoxication**, with confusion of mind and speech, excited gait and gesture, and thereafter convulsions, probably originating partly also in the medulla. Moderate doses are said to produce an aphrodisiac, followed by an anaphrodisiac, effect. The heart is stimulated directly, as well as reflexly from the stomach, as we have seen. Camphor has accordingly been used in nervous and cardiac prostration, especially in the acute specific fevers, such as typhoid and erysipelas; in poisoning by opium and other narcotics; in alcoholism, including delirium tremens; and in various nervous disorders, dependent probably on disturbance of the cerebral and spinal centres, such as insanity, hysteria, whooping cough, priapism and spermatorrhœa. In large doses of particular preparations, and probably in certain subjects, Camphor instead of excitement produces rapid depression chiefly referable to the heart: namely, failure of the pulse, pallor, coldness and moistness of the surface, impaired local sensibility and unconsciousness. The respiration is much disturbed after full doses, in association with convulsions and coma. Camphor is a decided **diaphoretic** through its action on the sweat centres. Its action on metabolism is unknown, except that it lowers the body temperature, both in health and in pyrexia. The two effects last named may contribute to the value of Camphor in fevers.

4. REMOTE LOCAL ACTIONS AND USES.

Camphor is excreted unchanged by the respiratory organs, on which it probably acts like Turpentine. It is a common ingredient of **expectorant** mixtures, especially as the Compound Tincture. The skin also throws out Camphor, which not only specifically increases the perspiration, but imparts its odour to it. This **refrigerant** action accounts for the popular use of the drug in common colds. The kidneys do not excrete Camphor as such, but as a complex product.

Sassafras Radix.—Sassafras Root. The dried root of Sassafras officinale.

Characters.—Large branched pieces, covered with bark. Bark rough, greyish-brown externally; internally smooth, glistening, rusty-brown; odour agreeable, aromatic; taste peculiar, aromatic, somewhat astringent. Wood soft, light; greyish-yellow or greyish-red, with a more feeble taste and odour than the bark.

Composition.—Sassafras contains a *volatile oil*, consisting chiefly of *sassafrol*, $C_{10}H_{10}O_2$, and a terpene; a *resin;* and a neutral crystalline body, *sassafrin.*

Sassafras is contained in Liquor Sarsæ Compositus Concentratus.

ACTIONS AND USES.

The physiological actions of Sassafras are unknown. The drug is rarely used alone, but in the Concentrated Compound Solution of Sarsaparilla. It is supposed to increase the actions of the skin and kidneys in syphilis and rheumatism and to be useful in these diseases. See *Sarsæ Radix*, page 410.

ARISTOLOCHIÆ.

Serpentariæ Rhizoma.—Serpentary Rhizome. The dried rhizome and roots of (1) Aristolochia Serpentaria, or (2) Aristolochia reticulata.

Characters.—(1) The rhizome of Aristolochia serpentaria is tortuous and slender; about 1 inch long and $\frac{1}{8}$ inch in diameter; bears on its upper surface the remains of aërial stems, and on its under surface numerous wiry interlacing roots 3 inches in length. Both rhizome and roots are dull yellowish-brown, and have a characteristic camphoraceous odour, and a strong aromatic bitter taste. (2) The rhizome and roots of Aristolochia reticulata resemble the foregoing, but are longer and thicker, and the roots are straighter than those of Aristolochia serpentaria. *Substances resembling Serpentary:* Arnica, Valerian (*q.v.*).

Composition.—Serpentary contains chiefly a *volatile oil*, and a *resin*, with some *bitter* principle.

Preparations.

1. **Infusum Serpentariæ.**—1 in 20 of boiling Water. *Dose*, $\frac{1}{2}$ to 1 fl.oz.

2. **Liquor Serpentariæ Concentratus.**—Alcoholic, 1 in 2; by percolation. *Dose*, ½ to 2 fl.dr.

3. **Tinctura Serpentariæ.**—1 in 5 of Alcohol 70 per cent.; by percolation. *Dose*, ½ to 1 fl.dr.

Serpentary is contained in Tinctura Cinchonæ Composita.

ACTIONS AND USES.

Serpentary possesses **local and general stimulant and tonic** properties, closely resembling those of Valerian and Cascarilla. It is occasionally used in nervous, despondent, or excitable conditions, as well as in low fevers and febrile states.

SANTALACEÆ.

Oleum Santali.—Oil of Sandal Wood. Oil of Santal Wood. The oil distilled from the wood of Santalum album.

Characters.—Viscid, pale yellow; odour strongly aromatic; taste pungent, spicy. *Solubility.*—1 in 6 of alcohol 70 per cent. Sp. gr. ·975 to ·980. Contains two bodies $C_{15}H_{24}O$ and $C_{15}H_{26}O$. *Dose*, 5 to 30 min. (in capsules or as emulsion).

ACTIONS AND USES.

Oil of Sandal Wood **resembles Copaiba** in its actions and uses, but is more easily taken. *See* page 281.

THYMELACEÆ.

Mezerei Cortex.—Mezereon Bark. The dried bark of Daphne Mezereum, or of Daphne Laureola, or of Daphne Gnidium.

Characters.—Long, thin, flattened strips, or small quills. Very tough and fibrous; externally olive-brown, deeply purplish-brown or reddish-brown; internally nearly white, silky. No marked odour; taste acrid, burning.

Composition.—Mezereon contains an active acrid *resin*, the anhydride of a resinous acid, *mezereinic acid;* an inert

fixed oil; and a glucoside, *daphnin*, $C_{31}H_{34}O_{19}$, also probably inactive.

Mezereon is an ingredient of Liquor Sarsæ Compositus Concentratus.

ACTIONS AND USES.

Mezereon is a powerful **local irritant**, like Mustard, **causing vesication** (*see* page 243). Internally it is **stimulant** and **diaphoretic**; in large doses an irritant poison.

EUPHORBIACEÆ.

Cascarilla.—Cascarilla. The dried bark of Croton Eluteria.

Characters.—In quills, 1 to 3 inches or more in length, $\frac{1}{8}$ to $\frac{1}{2}$ inch in diameter; or in small curved pieces. Outer layer consists of a dull-brown or dark-grey longitudinally wrinkled cork, marked with small longitudinal and transverse cracks, and covered with silvery-grey patches, spotted with minute black dots; it easily separates, disclosing a brown or dark-grey inner layer marked with longitudinal and transverse furrows. Fracture short and resinous. Odour agreeable, aromatic, especially when burned; taste aromatic, bitter. *Substance resembling Cascarilla.*—Pale Cinchona Bark; less white, smooth, and small.

Composition.—Cascarilla contains a complex mixture of *volatile oils* and *resins*, a crystalline bitter principle, *cascarillin*, $C_{12}H_{11}O_4$, *starch*, *tannic acid*, etc. *Incompatibles.*—Lime water, metallic salts, mineral acids.

Preparations.

1. **Infusum Cascarillæ.**—1 in 20 of boiling Water. *Dose*, $\frac{1}{2}$ to 1 fl.oz.

2. **Tinctura Cascarillæ.**—1 in 5 of Alcohol 70 per cent.; by percolation. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

ACTIONS AND USES.

Cascarilla acts in virtue of the aromatic oils and the bitter principle which it contains. It is a pleasant and useful **aromatic bitter stomachic.** *See* pages 292 and 220.

Oleum Crotonis.—Croton Oil. The oil expressed from the seeds of Croton Tiglium.

Characters.—Brownish-yellow to dark reddish-brown; viscid; odour disagreeable; taste burning and acrid. *Solubility.*—Entirely soluble in absolute alcohol; freely in ether and chloroform. Sp. gr. ·940 to ·960.

Characters of the Seeds (non-official).—About the size of a coffee bean, oval or oval-oblong, dull brownish-grey, without odour. *Substances resembling Croton Oil seeds.*—Castor Oil seeds, which are bright, polished, and mottled.

Composition.—The active principle of Croton Oil is *crotonol acid*, a vesicating and purgative principle. Several *fixed oils* (olein, palmitin, stearin, myristin, and laurin), as well as their free acids, can also be extracted from it; and several *volatile acids* (only 1 per cent. in all), which give its odour to Croton Oil, namely, acetic, butyric, valerianic, and tiglic ($HC_5H_7O_2$) acids, and are formed from the fixed oils after extraction. *Impurities*—Other non-drying oils.

Dose, ½ to 1 min.

Preparation.

Linimentum Crotonis.—1; Oil of Cajuput, 3·5; Alcohol 90 per cent., 3·5.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Croton Oil is a **powerful irritant** to the skin; causing a burning sensation and redness, followed by a crop of papules and finally severe pustules. These last for days, heal by scabbing, and may leave unsightly cicatrices. The Liniment is much less used than formerly as a counter-irritant in affections of internal parts, especially the lungs and joints. The Oil is applied to the scalp in ringworm.

Internally, also, Croton Oil is a powerful irritant, causing burning in the throat, heat in the epigastrium, possibly nausea and purgation. It acts as a very rapid **drastic cathartic**, with some pain, producing a motion within 1 to 2 hours, which is partly solid; the effect being repeated several times during the next twelve hours in a more liquid form. The irritant effect consists chiefly in direct inflammation of the mucous membrane, with increased watery transudation, heightened peristaltic action, and probably glandular (not biliary) hypersecretion. The muscular excitement and consequent griping, however, commence before the Oil has

reached the duodenum, to be acted on by the pancreatic juice and bile, and are, therefore, partly reflex acts, originating in irritation of the gastric nerves, section of the vagi postponing its purgative effect in animals. This accounts for the rapid action of the drug.

Croton Oil is used when a speedy and complete evacuation of the bowels, and a diminution of the arterial pressure, are demanded. It is a proper purgative in some cases of cerebral hæmorrhage; in intestinal obstruction from impacted fæces; or in constipation where other purgatives have failed and a structural obstacle does not exist. The smallness of the dose, which can be put in food, or mixed with a little butter and smeared on the back of the tongue, renders it a convenient purgative for insane or unconscious patients. Croton Oil must be given with great care; and is inadmissible in feeble subjects, in organic obstruction, and in inflammatory states of the stomach and intestines.

2. Actions in the Blood, and Specific Actions.

Croton Oil or its products are occasionally absorbed, and may cause disturbance of the heart and nervous centres.

Oleum Ricini.—Castor Oil. The oil expressed from the seeds of Ricinus communis.

Characters.—Viscid, colourless or a faint yellow; odour slight; taste bland at first, then acrid and unpleasant. *Solubility.*—1 in 1 of absolute alcohol; 1 in 5 of alcohol 90 per cent. Sp. gr. ·950 to ·970.

Characters of the Seeds (non-official).—Oval, compressed, smooth, shining, grey, marbled with reddish- or blackish-brown spots and stripes. *Substance resembling Castor Oil seeds.*—Croton Oil seeds (*q.v.*).

Composition.—The bulk consists of *glyceryl ricinoleate*, $C_3H_5(C_{18}H_{33}O_3)_3$; palmitin, stearin, cholesterin, and possibly traces of a resin and an alkaloid also occur. *Impurities.*—Various fixed oils, including cotton-seed oil. *Dose*, 1 to 8 fl.dr.

Preparation.

Mistura Olei Ricini.—75; Mucilage of Gum Acacia, 37·5; Orange Flower Water of Commerce (undiluted), 25; Cinnamon Water, 62·5. 3 fl. dr. in 1 fl. oz. *Dose*, 1 to 2 fl. oz., as a draught.

Oleum Ricini is contained in Collodium Flexile, Linimentum Sinapis, and Pilula Hydrargyri Subchloridi Composita.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, pure Castor Oil is bland, like Almond Oil; and is applied as a local sedative and protective, for example, in injury of the conjunctiva by quicklime.

Internally, Castor Oil, if pure, is perfectly non-irritant until it reaches the duodenum, where it is decomposed by the pancreatic juice, and the ricinoleic acid at once comes into action. If the Oil be rancid, it will irritate the stomach and cause nausea and vomiting.

Castor Oil is a **simple purgative**, at once rapid and certain, mild and painless; producing one or more liquid but not watery stools in four to six hours, **followed by a sedative effect.** It is believed to stimulate the muscular coat and intestinal glands, but not the liver. It purges also as enema. Castor Oil is used as the best of all simple purgatives when only a free evacuation of the bowels is desired. It can be given in all conditions where a laxative is permissible; and it is therefore specially employed in the treatment of diarrhœa due to the presence of indigestible or undigested food in the bowels, in the constipation of typhoid fever, after abdominal operations, in pregnancy, and *post partum*. It is a valuable purgative for children and for the old and infirm. In some forms of indigestion in infants, small doses (5 min. for an infant) may be given three or four times a day for days or even weeks, as an emulsion, with the best result. Small doses of Tincture of Opium are sometimes combined with Castor Oil.

2. ACTIONS IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

Ricinoleic acid enters the blood and tissues, and leaves the body in the excretions, including the milk, which purges infants at the breast.

The *Leaves* of the Castor Oil Tree, applied locally to the mammæ as a poultice, are said to be galactagogue.

PIPERACEÆ.

Piper Nigrum.—BLACK PEPPER. The dried *unripe* fruit of Piper nigrum.

Characters.—Almost black, nearly globular, inferior, one-celled fruits, usually about $\frac{1}{5}$ inch in diameter. Pericarp deeply and reticulately wrinkled; containing a single seed that completely fills the cavity. Odour aromatic; taste pungent. *Substances resembling Black Pepper.*—Pimento, which has calyx; Cubebs, which is stalked.

Composition.—Pepper contains a *volatile oil*, isomeric with Turpentine, with the odour of pepper; a complex *resin;* and a tasteless crystalline alkaloid, *piperine*, $C_{17}H_{19}NO_3$ (that is, isomeric with Morphine), which can be broken up into piperic acid and *piperidine*, $C_5H_{11}N$, a liquid alkaloid, homologous with conine, with powerful odour and taste.

Preparation.

Confectio Piperis.—2; Caraway Fruit, 3; Clarified Honey, 15. *Dose*, 1 to 2 dr.

Piper Nigrum is also contained in Pulvis Opii Compositus.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally, Pepper is a domestic rubefacient, anodyne and counter-irritant, like Mustard.

Internally, it acts as an **aromatic and local stimulant** in the mouth, stomach and intestine. As a condiment, it assists gastric digestion like other substances of the same class. It is a useful **carminative**; and may be prescribed in pills containing irritant substances, such as Digitalis.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS AND USES.

The volatile oil of Pepper acts like its allies. Piperine is believed to possess the antiperiodic and antipyretic actions of Quinine; and Pepper was once a domestic remedy for ague, which may still be used in cases where the appetite fails. Piperidine greatly raises the blood-pressure.

3. REMOTE LOCAL ACTIONS AND USES.

Some of the constituents of pepper are excreted by the kidneys, and probably by the intestinal mucous membrane, and act as **remote local stimulants** of the circulation and nutrition in the **urethra and rectum.** Pepper **is occasionally** used in gleet; but much more extensively for **hæmorrhoids and other diseases of the rectum.**

Cubebæ Fructus.—Cubebs. The dried, full-grown, *unripe* fruits of Piper Cubeba.

Characters.—Nearly globular, sometimes depressed at the base, about $\frac{1}{6}$ inch in diameter, greyish-brown or nearly black in colour. Pericarp reticulately wrinkled, thin, brittle, abruptly prolonged at the base into a slender rounded stalk which is $1\frac{1}{2}$ times the length of the globular portion; within it are usually the shrivelled remains of a single seed attached by the base. Odour strong, aromatic, characteristic; taste warm, aromatic, somewhat bitter. The crushed fruit imparts a crimson colour to sulphuric acid (presence of cubebin). *Substances resembling Cubebs.*—Pimento and Pepper, which have no stalk.

Composition.—Cubebs consists of 6 to 15 per cent. of the official *volatile oil;* 2 per cent. of *cubebin*, $C_{33}H_{34}O_{10}$, a neutral, odourless, and tasteless body, insoluble in water; 6 per cent. of a *resin* containing *cubebic acid;* some *piperine;* a fatty oil; and gum. *Dose*, 30 to 60 gr.

Preparation.

Tinctura Cubebæ.—1 in 5 of Alcohol 90 per cent.; by percolation. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

From Cubebæ Fructus is made:

Oleum Cubebæ.—The Oil distilled from Cubebs.

Characters.—Colourless, pale-green or greenish-yellow, with the odour and camphoraceous taste of Cubebs. Sp. gr., ·910 to ·930.

Composition.—Consists chiefly of *cubebene*, $C_{15}H_{24}$, with a stearoptene, and a little terpene. *Dose*, 5 to 20 min. (with mucilage).

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

The actions of Cubebs closely resemble those of common Pepper, but different parts of the body are affected in different degrees. Cubebs is an aromatic stomachic, in small doses; in large doses it is apt to derange the digestion; in very large doses it is a gastro-intestinal irritant.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS.

The active principles of Cubebs enter the blood, and thence the tissues. Large doses probably have actions

similar to those of Turpentine, but no use is made of it on this account.

3. REMOTE LOCAL ACTIONS AND USES.

The principal effects of Cubebs Pepper are produced when it is leaving the body by the kidneys and urinary passages, the skin, and the respiratory organs. In this respect it closely resembles Copaiba, and is used in the same class of cases as it. Thus, it is a diuretic, acting directly on the renal cells. The cubebic acid is excreted in the urine as a salt, from which it may be precipitated by nitric acid; and this stimulates and disinfects the genito-urinary passages with which it comes in contact. The sweat and the bronchial mucus are both increased, and sometimes an eruption appears on the skin.

Cubebs is chiefly used in gonorrhœa and vesical affections. It is decidedly less unpleasant than Copaiba, and much less liable to disturb digestion. Sometimes it is prescribed for chronic bronchitis.

SALICACEÆ.

Salicinum.—Salicin. $C_6H_{11}O_5 \cdot O \cdot C_6H_4 \cdot CH_2OH$. *Source.*—Obtainable from the bark of various species of Salix and of Populus.

Characters.—Colourless, shining, trimetric tabular crystals; taste very bitter. *Solubility.*—1 in 28 of cold water; 1 in 60 of alcohol 90 per cent.; insoluble in ether. A glucoside. Sulphuric Acid colours it red. Heated with K_2CrO_4,CrO_3, a few drops of H_2SO_4, and some water, it yields salicylic aldehyde, having the odour of meadow-sweet. *Dose*, 2 to 20 gr.

Acidum Salicylicum. — Salicylic Acid, $C_6H_4 \cdot OH \cdot COOH$.

Source.—Obtained (1) from *natural* salicylates, such as the oils of wintergreen (Gaultheria procumbens, N.O. Ericaceæ), and sweet birch (Betula lenta, N.O. Amentaceæ); or (2) by the interaction of sodium carbolate and carbonic anhydride.

Characters.—Distinct, prismatic, colourless crystals. Taste at first sweetish, then acid, leaving a burning sensation in the throat. *Solubility.*—1 in about 500 of cold, 1 in 15 of hot, water; 1 in 3 of alcohol 90 per cent.; 1 in 2 of ether; 1 in 200 of glycerin; dissolves in solutions of ammonium citrate, ammonium acetate, sodium phosphate, or borax; also in solutions

of alkaline hydroxides and carbonates, salicylates being produced. Solutions of salicylates, if not weaker than 1 per cent., afford a yellowish-brown precipitate with solution of uranium nitrate (distinction from carbolates and sulphocarbolates). The crystals melt at 312·8° F. to 314·6° F., and below 392° F. volatilise without decomposition. *Impurities.*—Iron, paracresotic acid, colouring matter, and phenol. *Incompatible* with Spiritus Ætheris Nitrosi and Quinine. *Dose*, 5 to 20 gr.

Preparation.

Unguentum Acidi Salicylici.—1 to 49 of Paraffin Ointment, white.

Salicylic Acid is contained in Injectio Cocainæ Hypodermica and Liquor Atropinæ Sulphatis.

From Acidum Salicylicum is made:

Sodii Salicylas.—Sodium Salicylate. $(C_6H_4 \cdot OH \cdot COONa)_2, H_2O$. *Source.*—May be obtained by the interaction of Salicylic Acid and Sodium Carbonate or Sodium Hydroxide.

Characters.—Small colourless scales, or tabular crystals having a pearly lustre; inodorous; taste sweetish, somewhat unpleasant, saline. *Solubility.*—1 in less than 1 of water; 1 in 6 of alcohol 90 per cent.; solutions neutral or faintly acid. *Impurities.*—Carbolates, sulphocarbolates. *Dose*, 10 to 30 gr.

From Sodii Salicylas is made:

Bismuthi Salicylas.—Bismuth Salicylate. *See* Bismuthum, page 120.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Salicylic Acid acts as an **antiseptic and disinfectant,** not inferior to Phenol, 1 part in 60 killing developed bacteria. At the same time it stimulates the local circulation. It is extensively used as a surgical dressing in the form of cotton wool impregnated with the Acid by the aid of glycerin. On the contrary Sodium Salicylate has no antiseptic or disinfectant power, unless combined with a mineral acid to liberate the Salicylic Acid. Salicylic Acid in powder, diluted with talc, is an **anhidrotic,** checking local perspirations of the feet, or the general perspirations of phthisis. Neither substance is absorbed by the unbroken skin.

Internally.—Salicylic Acid causes sneezing and cough when applied to the nose or inhaled, like Benzoic Acid; and when admitted to the stomach is also a local irritant, causing heat, pain, nausea and vomiting, unless in moderate doses well diluted. The Sodium salt is very much less irritant, and may be freely administered if pure. The latter drug is used for sarcinous vomiting and in some cases of chronic dyspepsia with decomposition. Salicin is a useful **bitter stomachic.** In the bowel it is partly converted into saligenin ($C_7H_8O_2$) and glucose; and the former is in turn broken up into salicyluric ($HC_9H_8NO_4$), salicylic, and salicylous ($HC_7H_5O_2$) acids. Bismuth Salicylate is an **intestinal disinfectant.**

2. ACTIONS IN THE BLOOD, AND ITS USES.

Salicylic Acid necessarily exists in the blood as sodium salicylate, being taken up with considerable rapidity. The Acid is possibly again liberated in part by the free carbonic acid of the plasma in inflamed parts of the body, and thus exerts its antiseptic action within the body; but this is doubtful. Either in the blood, or in some of the tissues, a portion unites with glycocine (just like Benzoic Acid), and forms salicyluric acid (comparably with hippuric acid), thus: $HC_7H_5O_3 + C_2H_3(NH_2)O_2$ (glycocine) $= HC_9H_8NO_4$ (salicyluric acid) $+ H_2O$.

As regards Salicin, the decomposition begun in the bowel is continued in the blood.

3. SPECIFIC ACTIONS AND USES.

The actions of Salicylic Acid and its Sodium salt in the tissues are identical, since the former is converted into the latter. A moderate dose causes increased cardiac action, flushing and warmth of the surface, perspiration, a full feeling in the head, tinnitus, deafness, impairment of vision, and possibly a slight fall of temperature; and the products of nitrogenous waste (urea and uric acid) are said to be somewhat increased. Larger doses may cause delirium, especially with visual hallucinations; respiration is temporarily disturbed; the heart is depressed after the primary excitation; the vessels are relaxed, and the blood-pressure falls; perspiration is increased; the peripheral nerves, both sensory and motor, are unaffected.

All these phenomena in the healthy subject, taken together, do not account for the remarkable effect of Salicylates upon the body temperature in pyrexia or fever, that is, as **powerful antipyretics.** Two or more moderate doses (15 to 20 gr.) within one or two hours reduce pyrexial temperatures

several degrees, according to the disease and subject. It is therefore probable that the Salicylates act upon some *pathological* cause of pyrexia, possibly on the different viruses of the specific fevers.

Sodium Salicylate is employed in two allied but distinct classes of cases: 1. In pyrexia from any cause, such as influenza, pneumonia, pyæmia, etc., it is a simple and powerful antipyretic. In this respect it is comparable with Quinine; only more rapid in its action, less lasting in its effects, and more depressant to the circulation. It might be given in these diseases in single full doses when the temperature exceeds a certain height, say 103° F. 2. In acute rheumatism, Sodium Salicylate is distinctly a specific (much as Quinine is a specific against malaria), reducing the temperature, relieving the pain, removing the swelling and other local symptoms, and shortening the duration of the disease. By thus curtailing the course of rheumatism, this drug may indirectly reduce the liability to cardiac and other complications; but it is of no great service directly in this respect. It is of no use in chronic rheumatism; of doubtful value in rheumatic sciatica. Occasionally it affords relief in acute gout. It may be given either in wafers or in solution; and is sometimes combined with Potassium Bicarbonate in free doses (20 gr.). When the pyrexia declines, the dose of the Salicylate must be most gradually reduced, relapses being common after its discontinuance.

Some forms of diabetes mellitus are successfully treated with Salicylates. The Sodium salt is a direct cholagogue.

Salicin may be used for the same purposes as the Salicylates; its action, if less powerful, being better sustained, and the cardiac and vascular depression less marked.

4. REMOTE LOCAL ACTIONS AND USES.

Salicylic Acid is but slowly excreted in the urine, sweat, saliva, bile, and mucous secretions generally: mostly as salicylates or the free acid, partly as salicyluric acid. Salicin and Salicylic Acid occasionally induce a morbilliform eruption. Their most important action remotely is on the kidneys and urinary passages, where they are stimulant and disinfectant, at the same time **increasing the acidity of the secretion.** They are thus adapted for the treatment of chronic inflammatory affections of the bladder with foul alkaline urine and phosphatic deposits. Sometimes, however, the Salicyl compounds so irritate the kidney as to cause albuminuria, and even hæmaturia; and they must be used with great caution, when given for these or other purposes, if renal or

hepatic disease be present, and in aged persons, inasmuch as under their influence there is an increase of the amount of uric acid waste, and they are apparently not diuretic. Salicylates are believed by some authorities to be harmful in gout.

LIQUIDAMBARACEÆ.

Styrax Præparatus.—Prepared Storax.

Source.—Obtained from the trunk of Liquidambar orientalis, and purified by solution in ethylic alcohol, filtration, and evaporation of the solvent.

Characters.—A semi-transparent, brownish-yellow, semi-liquid balsam, with a strong agreeable odour and balsamic taste. Heated in a test-tube in boiling water it becomes more liquid, but gives off no moisture; boiled with solution of potassium bichromate and sulphuric acid, it evolves an odour resembling that of essential oil of bitter almonds.

Composition.—Storax consists of a volatile oil, *styrol*, C_8H_8; *cinnamic acid; cinnamate of cinnamyl* (styracin), C_8H_7CO, OC_9H_9; and various *resins*. Cinnamic acid, $C_6H_5{\cdot}CH{\cdot}CH{\cdot}COOH$, which occurs also in Cinnamon and the Balsams of Peru and Tolu, is a colourless, odourless, crystalline body, closely allied to Benzoic Acid, into which it can be oxydised.

Storax is contained in Tinctura Benzoini Composita.

ACTIONS AND USES.

Storax is a **local and remote stimulant, antiseptic and disinfectant,** like Benzoin and the Balsams of Peru and Tolu. It is used for scabies and phthiriasis. See pages 272 and 273.

HAMAMELIDACEÆ.

Hamamelidis Cortex.—Hamamelis Bark. Witch Hazel Bark. The dried bark of Hamamelis virginiana.

Characters.—In curved pieces, 2 to 8 inches long, $\frac{1}{16}$ inch thick; with silvery-grey scaly cork; externally brownish-red; internally pale reddish-pink, striated; fracture fibrous, laminated; odour not appreciable; taste slightly astringent.

Hamamelidis Folia.—Hamamelis Leaves.

Witch Hazel Leaves. The leaves fresh and dried of Hamamelis virginiana.

Characters.—Broadly oval in outline, varying in length from 3 to 6 inches. Upper surface dark green or brownish-green, the under surface paler; apex obtuse, margin sinuate. The leaves are narrowed towards the base, oblique, slightly cordate and shortly petiolate. They are pinnately veined, the veins being prominent on the under surface, where they are furnished with stellate hairs. Odour not marked; taste astringent, slightly bitter.

Composition.—Hamamelis contains traces of *tannic acid*, bitter and odorous matters, and an unknown active principle.

Preparations.

A. *Of Hamamelidis Cortex:*

Tinctura Hamamelidis.—1 in 10 of Alcohol 45 per cent.; by percolation. *Dose*, 30 to 60 min.

B. *Of Hamamelidis Folia:*

1. **Extractum Hamamelidis Liquidum.**—1 of *dried* leaves in 1; alcoholic. *Dose*, 5 to 15 min.

From Extractum Hamamelidis Liquidum is prepared:

UNGUENTUM HAMAMELIDIS.—1; Hydrous Wool Fat, 9.

2. **Liquor Hamamelidis.**—Made from the *fresh* leaves by maceration in Alcohol 90 per cent., and water; and distillation.

ACTIONS AND USES.

Hamamelis is an **astringent and hæmostatic** both locally and remotely. It is useful in hæmorrhoids, and in hæmorrhages from the nose, lungs, rectum and uterus.

CUPULIFERÆ.

Galla.—GALLS. Excrescences on Quercus infectoria, resulting from the puncture and deposition of an egg or eggs of Cynips Gallæ tinctoriæ.

Characters.—Hard, heavy, sub-globular; from ½ to ¾ inch or more in diameter; tuberculated on the surface, the

tubercules and intervening spaces smooth; dark bluish-green, or dark olive-green externally; yellowish- or brownish-white within, with a small central cavity. No odour; taste intensely astringent.

Composition.—Galls contain from 25 to 75 per cent. of *tannic acid*, and possibly some *gallic acid*.

Preparations.

1. Unguentum Gallæ.—1 in 4 of Benzoated Lard.

From Unguentum Gallæ is prepared:

Unguentum Gallæ cum Opio. — 37; Opium, 3. Contains 7·5 per cent. of Opium.

From Galls is made:

2. Acidum Tannicum.—Tannic Acid. Tannin. $C_{14}H_{10}O_9,2H_2O$.

Source.—May be extracted by water-saturated ether from Galls which have been subjected to a special fermentation.

Characters.—A light brownish powder consisting of thin glistening scales; odour characteristic; taste strongly astringent; reaction acid. *Solubility.*—1 in 1 of water, or of alcohol 90 per cent.; 1 slowly in 1 of glycerin. It is precipitated from its aqueous solution, and loses its astringency, in the presence of many mineral salts and acids. *Incompatibles.* — Gelatin (which it precipitates yellowish-white, distinguishing it from Gallic acid); mineral acids; alkalis; salts of antimony, lead and silver; ferric salts (with which it affords a bluish-black colour); most alkaloids; vegetable emulsions. *Dose*, 2 to 5 gr.

Preparations.

a. **Glycerinum Acidi Tannici.**—1 in 5; by trituration.

b. **Suppositoria Acidi Tannici.**—3 gr. in each with 12 gr. of Oil of Theobroma.

c. **Trochiscus Acidi Tannici.**—$\frac{1}{2}$ gr.; with the Fruit Basis.

From Tannic Acid is made:

Acidum Gallicum. — Gallic Acid. $C_6H_2(OH)_3COOH,H_2O$. A trihydroxybenzoic acid.

Source.—May be prepared by the action of Diluted Sulphuric Acid on Tannic Acid.

Characters.—Acicular prisms or silky needles, sometimes nearly white, but generally of a brownish tinge; odourless; of a faintly acid taste. *Solubility.*—1 in 100 of cold, 1 in 3 of boiling, water; 1 in 5 of alcohol 90 per cent.; 1 in 40 of ether; 1 in 12 of glycerin. Gives a bluish-black precipitate with ferric salts, but simply darkens ferrous salts. *Resembles* Tannic Acid, but has no astringent taste, and does not precipitate solutions of gelatin. *Incompatibles.*—Spiritus Ætheris Nitrosi; metallic salts, including ferric salts. *Impurities.*—Tannic acid, mineral matter, sulphates. *Dose*, 5 to 15 gr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—The actions of Tannic Acid, and of the many official substances containing it, depend chiefly upon its property of precipitating albumen and gelatin. When applied to the broken skin or to exposed mucous surfaces, it condenses or "tans" the albuminous and connective tissues, and coagulates the fluids pervading the solid elements (an action which in the dead skin converts the whole into leather). At the same time the sensibility of the nerves is reduced. The vessels of the part are compressed by the constringed connective tissues to such a degree that their size is indirectly reduced; the circulation through them is diminished; and any hæmorrhage from them is arrested by pressure and by coagulation of the blood by the Acid. If a "passive" discharge of plasma and leucocytes be escaping from their walls, as in chronic inflammation, the exudation is stopped. Thus Tannic Acid is a powerful indirect **styptic and a constringent.** Broken surfaces, such as ulcers, have their superficial layers of cells condensed, and the discharge coagulated, with some **disinfectant** effect, the action as a whole promoting healing. It is an important fact that Tannic Acid does not *actively* contract blood-vessels, like Lead and Silver; on the contrary, it dilates them; but its *indirect* constringent influence more than neutralises this effect.

There is hardly a limit to the application of Tannic Acid and preparations containing it, as styptics and astringents.

Superficial hæmorrhage from small wounds, the nose, gums, throat, etc., and chronic or subacute inflammatory discharges from the skin, eyes, nose, urethra, vagina, womb or rectum, may all be treated with it. The Acid may be used solid, being dusted or insufflated on the part; applied in solution as injection, lotion, etc.; or inserted into canals or cavities as bougies or the Suppositories. The two Ointments of Galls are favourite applications to hæmorrhoids.

Internally.—In the *mouth*, Tannic Acid produces its peculiar "taste," with a sensation of astringency, dryness, roughness, stiffness of the tongue and throat, and thirst; the parts being constringed and partly anæsthetised, and the other effects produced, as described externally. Preparations containing this drug are in much request in chronic sore throat with a relaxed condition of the uvula, pharynx and larynx, slight catarrh, cough and occasional slight bleeding. The Trochiscus, gargles, sprays, or the Glycerin applied with a brush, may be used in different cases.

In the *stomach*, Tannic acid precipitates the pepsin with the albumens of the gastric juice; and, if in quantity, will interfere with digestion by this means, as well as by constringing the mucosa, reducing the circulation, and diminishing the secretion. On the contrary, if a chronic mucous catarrh be present, causing dyspepsia, Tannic acid in the form of Pulvis Catechu Compositus, etc., may give relief by arresting the morbid process, on the principles already discussed. In the stomach another highly important use is made of the drug, namely, as an **antidote** to antimony and such alkaloids as morphine or strychnine; a strong infusion of tea being given if no other tannate be at hand. An emetic or purgative should afterwards be given in alkaloidal poisoning, as the alkaloid-compounds with Tannic Acid are not perfectly insoluble.

The astringent effect of Tannic Acid is continued in the *intestines*. It and its compounds, including Di-acetyl-Tannin or Tannigen (not official) in 5 to 10 gr. doses, are the most popular remedies for diarrhœa, whether alone or combined with other astringents, with antacids such as Chalk, or with anodynes such as Opium. Intestinal hæmorrhage may sometimes be arrested by the same means. During its passage along the alimentary canal, part of the Tannic is converted into gallic acid, which enters the blood; the rest is excreted in the fæces:

Tannic Acid + water = gallic acid + glucose + carbonic anhydride

$$C_{14}H_{10}O_9,2H_2O + 3H_2O = C_6H_2(OH)_3COOH,H_2O + C_6H_{12}O_6 + CO_2$$

Gallic Acid possesses no local astringent properties, and is therefore seldom if ever given for immediate local purposes.

2. ACTIONS ON THE BLOOD.

Entering the circulation as Gallic Acid, the preparations of Tannin are not certainly known to have any further astringent effect on the vessels, any antiseptic action, or any coagulating influence on the blood. If injected directly into the veins, Tannic Acid proves rapidly fatal by clotting and embolism.

3. SPECIFIC ACTIONS AND USES.

The actions of these substances on the tissues must depend entirely on the Gallic Acid. This is generally regarded as a specific astringent and styptic, arresting chronic discharges from internal and distant parts, such as the uterus and rectum, and checking bleeding, especially hæmoptysis. For these purposes Gallic Acid is much used, and should be given in full doses, even up to 1 drachm at a time if hæmorrhage be urgent. It must be confessed that there is not sufficient evidence of this action or of the value of this employment of the drug.

4. REMOTE LOCAL ACTIONS AND USES.

Tannic and Gallic Acids are rapidly excreted, chiefly as Gallic Acid, partly as pyrogallic acid, in the urine, which is darkened in tint. No remote disinfectant effect is to be obtained in the kidneys or bladder; nor is Gallic Acid now believed to diminish the albuminuria of Bright's disease. Some hold that it arrests renal hæmorrhage; but in this, and in all kinds of hæmorrhage, there is a constant possible source of error, from the fact that the spontaneous arrest of bleeding is extremely common. Gallic Acid has also been used in night-sweating, with doubtful success.

URTICACEÆ.

Ficus.—FIGS. The dried fleshy receptacles of Ficus Carica.

Characters.—Consists of the enlarged hollow succulent receptacle, bearing very numerous achenes on its inner surface; it is compressed, irregular in form, soft, tough, brownish or yellowish, with a sweet taste.

Composition.—Figs contain *sugar* and *mucilaginous* substances.

Figs are contained in Confectio Sennæ.

ACTIONS AND USES.

The Fig is a very pleasant **demulcent and nutritive** substance with **laxative** properties, and may be ordered as an article of diet in habitual constipation.

Cannabis Indica. — INDIAN HEMP. Ganji or Gunjah. The dried flowering or fruiting tops of the *female* plant of Cannabis sativa, grown in India; from which the resin has not been removed.

Characters.—In compressed, rough, dusky-green masses, consisting of the branched upper part of the stem, bearing leaves and pistillate flowers or fruits, matted together by a resinous secretion. The upper leaves simple, alternate, 1–3-partite; the lower opposite and digitate, consisting of 5 to 7 linear-lanceolate leaflets, with distantly serrate margins. Fruit one-seeded, supported by an ovate-lanceolate bract. Both leaves and bracts bear external oleo-resin glands and one-celled, curved hairs, the bases of which are enlarged and contain cystoliths.

Composition.—Cannabis Indica has yielded an amorphous *resin;* a glucoside, *cannabin;* an active principle, *cannabinon;* a volatile alkaloid, *cannabinine;* another alkaloid, *tetano-cannabine;* and a volatile oil, *cannabene.* *Incompatibles.*—Water, and watery infusions, which precipitate the resin.

Preparations.

Extractum Cannabis Indicæ.—Alcoholic; by percolation and evaporation. *Dose,* $\frac{1}{4}$ to 1 gr. (in pill).

From the Extract is prepared:

TINCTURA CANNABIS INDICÆ.—1 of Extract in 19 of Alcohol 90 per cent.; by solution. *Dose,* 5 to 15 min. (with 1 fl.dr. of Mucilage).

Tincture of Indian Hemp is contained in Tinctura Chloroformi et Morphinæ Composita. See page 167.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS, AND ACTIONS IN THE BLOOD.

Positive knowledge on these points is wanting. Cannabis Indica is never used *externally.* *Internally* the Extract forms a useful corrective of some griping purgatives, such as Podophyllum Resin and Colocynth. It does not derange the stomach and intestines like Opium.

2. SPECIFIC ACTIONS AND USES.

The actions of Cannabis Indica are not well understood. The official preparations chiefly affect the convolutions. They produce a species of intoxication; disordered consciousness of personality, locality and time; and exaltation of the feelings, with pleasing grandiose ideas and hallucinations. Noisy, restless delirium supervenes, with muscular excitement or more commonly sleep; therewith pain may be relieved. The heart and the blood-vessels appear to be first stimulated and afterwards depressed. The physiological effects of the several constituents have not been fully determined. Cannabin and Cannabinon are the most important, the latter especially causing the intoxication. Tetano-cannabine is a convulsant.

Cannabis Indica was formerly used as a **hypnotic and anodyne,** when Opium disagreed or had been taken in excess; but, from its uncertainty, it has been generally replaced by Chloral Hydrate. Combined with Potassium Bromide, it is useful in mania. More frequently it is given in megrim, and as an indirect anodyne and **antispasmodic** in dysmenorrhœa, menorrhagia and hysteria. It may also be tried in neuralgia, and in spasmodic asthma (as cigarettes), when other remedies fail.

3. REMOTE LOCAL ACTIONS.

Nothing is definitely known respecting the excretion of Cannabis Indica. It increases the amount of urine, probably through the blood-pressure.

Lupulus.—HOPS. The dried strobiles of Humulus Lupulus; collected from cultivated plants.

Characters.—Strobiles about $1\frac{1}{4}$ inch long, oblong-ovoid or rounded; consisting of a number of imbricated greenish-yellow membranous stipules and bracts attached to a hairy zigzag axis. Each bract enfolds at its base a small rounded achene which, like the base of the bract, is sprinkled over with brownish-yellow glands. Odour aromatic, characteristic; taste bitter, aromatic, somewhat astringent.

Composition.—Hops contain an aromatic volatile oil, *valerol*, $C_6H_{10}O$, on which their odour depends; 11 per cent. of a crystalline bitter principle, *lupulinic acid*, $C_{32}H_{50}O_7$; possibly a liquid volatile alkaloid, *lupuline;* and *tannic acid.*

Incompatibles.—Mineral acids; metallic salts.

Preparations.

1. **Infusum Lupuli.**—1 in 20 of boiling Water. *Dose*, 1 to 2 fl.oz.

2. **Tinctura Lupuli.**—1 in 5 of Alcohol 60 per cent.; by maceration. *Dose*, ½ to 1 fl.dr.

Lupulinum.—Lupulin. Glands obtained from the strobiles of Humulus Lupulus.

Characters.—A granular brownish-yellow powder composed of minute glands, each consisting of a single hemispherical layer of cells, the cuticle of which has been raised by the secretion of the oil or oleo-resin contained in the gland. Odour strong, hop-like; taste bitter, aromatic. *Impurities.*—Dust, yielding more than 12 per cent. of ash. *Dose*, 2 to 5 gr.

ACTIONS AND USES.

The actions and uses of the Hop depend upon the presence of its two important constituents, which exert the characteristic effects of the class to which they respectively belong. (1) The primary stimulant, and secondary sedative and soporific effects of the **aromatic** oil, associated with those of alcohol, are seen in ales and beers, less distinctly in the official preparations. The **stomachic and tonic** effect of the hop-bitter, lupulinic acid, is equally familiar in wholesome bitter ale. Ale is moderately laxative and **diuretic**, by virtue of the essential oil and alcohol.

The Hop is used medicinally chiefly in the form of pure bitter ales, to produce the effects just described, especially to rouse and improve the appetite during convalescence and in low states of the system, and to **promote sleep**. The official preparations sometimes relieve the craving of alcoholism, and act as anaphrodisiacs. Lupulin is given as a hypnotic.

CONIFERÆ.

Oleum Terebinthinæ.—Oil of Turpentine.

Source.—Distilled, usually by the aid of steam, from the oleo-resin (turpentine) obtained from Pinus sylvestris and other species of Pinus; rectified if necessary.

Characters.—Limpid, colourless; odour strong, peculiar, varying in the different kinds of Oil; taste pungent, somewhat bitter. Boils about 320° F.; almost entirely distils

below 356° F. Mixes with other volatile and fixed oils, and dissolves resins, wax, sulphur, phosphorus and iodine. *Solubility.*—1 in 1 of Glacial Acetic Acid.

Composition.—The oleo-resin, common turpentine, as it is formed on trees, is an impure solution of *resin* in 15 to 30 per cent. of the official *volatile oil.* The Oil of Turpentine, $C_{10}H_{16}$, with the characters just described, readily absorbs oxygen on exposure to the air, and is converted into the resin, certain other acids, carbonic acid and ozone, which thus increase at the expense of the oil; the mixture constituting the oleo-resin. When the latter is distilled, after agitation with lime water, the volatile oil passes over, leaving the resin behind. Oil of Turpentine is isomeric with a number of volatile oils, or of their constituents, already met with in the materia medica.

Dose, 2 to 10 min.; as an anthelmintic, 3 to 4 fl.dr.

Preparations.

1. **Linimentum Terebinthinæ.**—26; Camphor, 2; rubbed up with Soft Soap, 3; mixed with Water, 10.

2. **Linimentum Terebinthinæ Aceticum.**—4; Glacial Acetic Acid, 1; Liniment of Camphor, 4.

From Oil of Turpentine is made:

Terebenum.—TEREBENE.—A mixture of dipentene and other hydrocarbons.

Source.—Obtained from Oil of Turpentine by agitation with Sulphuric Acid until it has no longer an action on polarised light; and then distilling in a current of steam.

Characters.—A colourless liquid. Odour agreeable; taste terebinthinate, aromatic. Sp. gr. ·862 to ·866. Inactive to polarised light. *Impurity.*—Excess of resin. *Dose*, 5 to 15 min.

Resina.—RESIN. *Source.*—The residue left after distillation of Oil of Turpentine from the crude oleo-resin (turpentine) of various species of Pinus.

Characters.—Translucent, light amber, compact, brittle, pulverisable; fracture shining. Odour and taste faintly terebinthinate. *Solubility.*—Soluble in alcohol 90 per cent., ether, carbon bisulphide and benzol. Easily fusible; burns with a dense yellow flame and much smoke, leaving no appreciable ash.

Composition.—Resin consists of three isomeric resinous

acids, *pinic*, *sylvic*, and *pimaric*, $HC_{20}H_{29}O_2$, and a trace of *oil of turpentine*.

Preparations.

1. **Emplastrum Resinæ.**—Resin Plaster. Adhesive Plaster. 4; Lead Plaster, 32; Hard Soap, 2.

2. **Unguentum Resinæ.**—Resin Ointment. "Basilicon Ointment." 4; Yellow Beeswax, 4; Olive Oil, 4; Lard, 3.

Resin is contained in many other plasters.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Applied to the skin or exposed mucous surfaces, Turpentine is **antiseptic and disinfectant**, and produces a sense of heat and redness, followed by burning and vesication, the local circulation being stimulated, and the local nerves first irritated and then depressed. Resin is a mild local stimulant and disinfectant. Turpentine is therefore in very extensive use as a **local stimulant and counter-irritant**: (*a*) In painful affections of a local kind, such as chronic rheumatism of muscles or joints and neuralgia, in the form of the Liniments, the Resin Plaster, and Turpentine stupes. (*b*) In affections of deep parts, to act reflexly on the vessels and nerves; for instance, to relieve bronchitis by being rubbed on the chest or applied to it in stupes, meteorism by application to the abdomen in stupes, or affections of joints by inunction over them. (*c*) As a disinfectant and stimulant it may be applied to ulcers and wounds, the Unguentum Resinæ being very useful for this purpose, whilst the pure Oil has been employed in hospital gangrene. Turpentine is absorbed by the unbroken skin, and its action in meteorism may be partly accounted for in this way, as we shall see. Resin also gives a consistence and adhesiveness to the many plasters of which it is an ingredient.

Internally.—In the stomach, as externally, Oil of Turpentine is disinfectant, stimulant to the vessels, sedative to the local nerves, and reflexly stimulant, at least for a time. In a word, it is a powerful carminative; but it is little given for this purpose, because unpleasant to the taste and often disagreeable in its remote effects, and because we have abundance of other volatile oils, equally powerful, without either of these drawbacks. See *Caryophyllum*, page 292.

Turpentine passes into the bowel, and may be found even

in the colon (which may, however, *excrete* it also, as will be described). Here it acts reflexly as a **stimulant to the muscular coat**, causing contraction, expulsion of gas and fæces, and recovery of tone if this has been lost by tympanitic distension; and is also a **disinfectant** and vascular stimulant. In larger doses these effects proceed to purgation. It is therefore given, either by the mouth or as an enema, in tympanites, especially when this is associated with constipation; and it has proved useful in some kinds of diarrhœa and in dysentery. It may also be advantageously added to enemata after some forms of intestinal hæmorrhage, being, as will be seen, hæmostatic.

Turpentine proves to be an **anthelmintic**, and is given either by the mouth, for the tape-worm, in doses of ʒij to ʒss, which sometimes cause unpleasant symptoms; or as an enema, for the thread-worm—an excellent method.

Another local application of Oil of Turpentine is to the respiratory organs, as an inhalation. The diluted vapour in steam should be used, or the pure vapour inhaled from a warm sponge, but this may prove too irritating. Turpentine enters the blood thus, but the chief action desired is a purely local one, to disinfect and stimulate the chronically inflamed or ulcerated surfaces of the bronchi and lungs, and to correct the odour and irritant properties of the products. It is used in dilated bronchi, tuberculosis, gangrene of the lung and allied conditions. Patients suffering from these diseases may possibly be benefited by the air of pine forests, *e.g.* at Bournemouth and Arcachon. Terebene, whether internally or in the form of an inhalation, is more agreeable than the Oil itself for employment in diseases of the respiratory organs.

2. Actions on the Blood.

Oil of Turpentine is freely absorbed by all surfaces, and enters the blood as such. Thus introduced, it produces none of the rapidly fatal effects which follow its injection into the veins of animals, and which are referable in part to coagulation. Probably, however, even in medicinal quantities, Turpentine is partially oxydised at the expense of the blood.

3. Specific Actions and Uses.

Found unchanged in the tissues and organs, Oil of Turpentine sets up a series of symptoms, mainly depressant in their character, which follow the reflex stimulant effects already described as referable to its action on the nerves and vessels of the stomach. A full dose produces languor, debility, nausea, dulness, sleepiness and unsteady gait; a large dose may lead to coma. These **sedative effects on the cerebral and**

spinal centres may account for the success of the empirical use of Turpentine in painful affections, such as neuralgia, obstinate sciatica and hepatic colic.

At the same time the heart is disturbed by the Oil, and the blood-pressure decidedly falls. Here we may find the explanation, in part, of the unquestionable value of Turpentine as a **hæmostatic.** Of all the means of arresting internal hæmorrhage, it frequently proves to be the most powerful: bleeding from the lungs, stomach, bowels, and uterus will often cease after a full dose of Turpentine when every other drug has failed. It is specially useful in intestinal hæmorrhage from typhoid ulceration. In such cases the Oil must be fearlessly exhibited, since life is at stake, a dose of ʒj being followed every two hours by doses of 20 to 30 min.

The temperature is believed to be lowered by Turpentine.

This substance is also a physiological **antidote to phosphorus,** and may be used (best in the form of the crude oil) either to prevent chronic phosphorus poisoning in workmen, or in small repeated doses in acute poisoning, after Copper Sulphate. See *Cuprum*, page 78.

4. REMOTE LOCAL ACTIONS AND USES.

Oil of Turpentine, like volatile oils in general, is excreted mainly as such, by the cutaneous and mammary glands, by the lungs and respiratory passages, by the kidneys, and possibly by the liver, biliary mucosa and intestines. All these organs are influenced by the Oil as it passes through them. Perspiration is slightly increased, and an eruption may appear on the skin. In the bronchial walls it acts as a vascular stimulant, and disinfects both these and their products; it might, therefore, be a valuable drug in chronic bronchitis, dilated bronchi and gangrene of the lungs. Its effects as it passes through the kidneys account for the comparatively little use that is made of Turpentine in these and other diseases. Even in moderate doses it may produce symptoms of **irritation and congestion of the urinary organs,** including lumbar pain, repeated distressing ineffectual attempts at micturition, a sense of heat and spasm in the perinæum, and frequently hæmaturia. But whilst large doses may cause complete suppression, small doses cause diuresis; and it may occasionally be used with caution in Bright's disease and even in hæmaturia. Part of the Turpentine is excreted as a fragrant violet-smelling body, and this and the unchanged portion exert a remote local effect as stimulants and disinfectants in the bladder and urethra, so that cystitis and gleet have been treated with the Oil.

In passing through the biliary passages, Turpentine or its products are believed by some authorities to prevent or dissolve gall stones. Its excretion by the colon probably contributes to its effect in expelling gas and fæces.

Terebinthina Canadensis.—CANADA TURPENTINE. Canada Balsam. *Source.*—Obtained from Abies balsamea.

Characters.—A pale-yellow and faintly-greenish transparent oleo-resin, of the consistence of thin honey, with a peculiar agreeable terebinthinate odour, and a slightly bitter, feebly acrid, taste; by exposure drying very slowly into a transparent varnish; solidifying when mixed with $\frac{1}{6}$ its weight of Magnesia, moistened with a little water.

Composition.—Canada Turpentine has the ordinary composition of Turpentine. See *Oleum Terebinthinæ*, page 400.

Terebinthina Canadensis is contained in Collodium Flexile.

ACTIONS AND USES.

Canada Turpentine is chiefly used for its physical properties. Internally it produces the effects of Oil of Turpentine.

Thus Americanum.—FRANKINCENSE. The concrete oleo-resin scraped off the trunks of Pinus palustris and Pinus Tæda.

Characters.—A rather soft, yellow, opaque, tough solid when fresh, having a terebinthinate odour. Dry, brittle, translucent, darker and of fainter odour when kept.

Composition.—Frankincense has the composition of ordinary crude turpentines.

Thus Americanum is contained in Emplastrum Picis.

ACTIONS AND USES.

Frankincense has the same actions and uses as resin and its allies just described.

Pix Burgundica.—Burgundy Pitch.

Source.—The resinous exudation obtained from the stem of Picea excelsa, melted and strained.

Characters.—Hard and brittle, yet gradually taking the form of the vessel in which it is kept; opaque; dull reddish-brown or yellowish-brown; fracture clean, conchoidal; odour aromatic, especially when heated; taste sweet, aromatic, not bitter. *Impurity.*—A mixture of common resin, oil, and water, not completely soluble in glacial acetic acid.

Composition.—Burgundy Pitch consists of various *resinous acids*, with *volatile oil*, as in ordinary crude Resin.

Preparation.

Emplastrum Picis.—26; Frankincense, 13; Resin, 4·5; Yellow Beeswax, 4·5; Olive Oil, 2; Water, 2.

ACTIONS AND USES.

Burgundy Pitch has a **mildly stimulant** action on the skin, and is used only for making plasters.

Pix Liquida.—Tar. Stockholm Tar. A bituminous liquid obtained from the wood of Pinus sylvestris and other species of Pinus by destructive distillation.

Characters.—Semi-liquid, dark brown or black, of a peculiar aromatic odour. Sp. gr. 1·02 to 1·15. Water agitated with it acquires a pale-brown colour, a sharp empyreumatic taste, and acid reaction. *Solubility.*—1 in 10 of alcohol 90 per cent.

Composition.—Tar is a variable mixture of *creosote*, *phenol* (carbolic acid), *toluol*, *xylol*, *acetic acid*, *turpentine* and *resinoid bodies*. *Dose*, 2 to 10 gr. (in pill with lycopodium).

Preparation.

Unguentum Picis Liquidæ.—Tar Ointment. 5; Yellow Beeswax, 2.

ACTIONS AND USES.

Externally, Tar is more valuable than either Creosote or Phenol as a **vascular stimulant and absorbent** in dry skin diseases, *e.g.* psoriasis, lichen planus, ichthyosis and certain forms of chronic eczema; and as a **nervous sedative** in pruritus.

Internally, Tar may be given as a **remote stimulant, disinfectant and deodorant** in winter cough and foul discharges from the bronchi and lungs, by which it is probably in part excreted. It is prescribed in the form of pills, capsules, syrup, or as tar-water, which is made by shaking up a pint of Tar with half-a-gallon of water, and decanting after settlement.

Oleum Cadinum. - Oil of Cade. Juniper Tar Oil. (*Huile de Cade.*) An empyreumatic oily liquid, obtained by the destructive distillation of the woody portions of Juniperus Oxycedrus, and some other species.

Characters.—A dark reddish-brown or nearly black, viscid oily liquid. Odour not unpleasant, empyreumatic; taste aromatic, bitter, acrid. Sp. gr. ·990. *Solubility.*—Soluble in ether and chloroform; partially in cold, completely in hot, alcohol 90 per cent.; very slightly in water; aqueous solution almost colourless, and acid in reaction.

ACTIONS AND USES.

Oil of Cade is **an agreeable form of Tar**, applied, combined with soap and alcohol, in chronic eczema, psoriasis, and other diseases of the skin, particularly if attended with itching.

Oleum Pini.—Oil of Pine. The oil distilled from the fresh leaves of Pinus Pumilio.

Characters.—Nearly colourless; odour pleasant, aromatic; taste pungent. Sp. gr. ·865 to ·870.

ACTIONS AND USES.

In its actions this substance resembles Turpentine, but is more agreeable. It is specially useful when administered in inhalation (rubbed up with Light Magnesium Carbonate) as a mild **stimulant, antispasmodic and disinfectant** in diseases of the larynx and bronchi.

Oleum Juniperi.—OIL OF JUNIPER. The oil distilled from the full-grown unripe green fruit of Juniperus communis.

Characters.—Colourless or pale greenish-yellow, of characteristic odour, and warm aromatic bitterish taste. Sp. gr. ·865 to ·890. *Solubility.*—1 in 4 of a mixture of equal parts of absolute alcohol and alcohol 90 per cent.

Composition.—Oil of Juniper contains a hydrocarbon $C_{10}H_{16}$, yielding a white crystalline hydrous compound $C_{10}H_{16}H_2O$, and a polymeric hydrocarbon $C_{20}H_{32}$. *Dose*, $\frac{1}{6}$ to 3 min.

Preparation.

Spiritus Juniperi.—1 in 20 of Alcohol 90 per cent.; agitated if necessary with powdered talc, and filtered. *Dose*, 20 to 60 min.

Spiritus Juniperi is contained in Mistura Creosoti.

ACTIONS AND USES.

Juniper closely resembles Turpentine in its action, but its effects on the kidneys are peculiarly marked, whilst it is neither disagreeable nor dangerously powerful. Thus it acts as a **stomachic, stimulant and anti-spasmodic**; is absorbed into the blood; is excreted in the urine, to which it imparts an odour of violets; is a **diuretic**, being possibly a specific stimulant of the renal cells, increasing both solids and water; and in large doses causes strangury and renal inflammation.

Juniper is used almost entirely as a diuretic in dropsy not dependent on acute renal disease, that is in cardiac and hepatic dropsy, and in some cases of chronic Bright's disease. It is best given combined with saline diuretics, or in the form of "Hollands" or Gin.

SCITAMINACEÆ.

Zingiber.—GINGER. The scraped and dried rhizome of Zingiber officinale.

Characters.—Flattish, irregularly-branched pieces, 3 to 4 inches long; a depressed scar at the summit of each branch. Externally pale buff, striated, fibrous; fracture ready, mealy,

short, fibrous, sometimes resinous. Odour agreeable, aromatic. Taste hot, pungent.

Composition.—Ginger contains an *aromatic volatile oil*, a complex mixture of hydrocarbons and their oxydation products; *cymene;* a terpene, aldehydes and ethereal salts.

Preparations.

1. **Syrupus Zingiberis.**—1 of a strong tincture by percolation; Syrup, 19. *Dose*, ½ to 1 fl.dr.

2. **Tinctura Zingiberis.**—1 in 10 of Alcohol 90 per cent.; by percolation. *Dose*, 30 to 60 min.

Ginger and Tincture of Ginger are also contained in a variety of preparations of important drugs.

ACTIONS AND USES.

Ginger acts and is used like other substances containing **aromatic** volatile oils. It is one of the most generally employed of **carminatives.**

Cardamomi Semina.—CARDAMOM SEEDS. Cardamoms. The dried ripe seeds of Elettaria Cardamomum. The seeds should be kept in their pericarps, and separated when required for use.

Characters.—Fruits from ⅖ to ⅘ inch in length; ovoid or oblong, bluntly triangular in section, shortly beaked at the apex, pale buff, longitudinally striated. Seeds dark reddish-brown, about ⅛ inch in length and the same in breadth and thickness, irregularly angular, transversely wrinkled, enclosed in a thin, colourless, membranous aril. Odour and taste agreeably warm and aromatic.

Composition.—The active principle is a *volatile oil*, containing a terpene, $C_{10}H_{16}$, and a camphor.

Preparation.

Tinctura Cardamomi Composita.—12·5; Caraway Fruit, 12·5; Raisins, 100; Cinnamon Bark, 25; Cochineal, 6·3; Alcohol 60 per cent., 1000. By maceration. *Dose*, ½ to 1 fl.dr.

Cardamom Seeds and the Compound Tincture are contained in a variety of important preparations.

ACTIONS AND USES.

Cardamom Seeds serve as a highly agreeable, slightly stimulant **flavouring and carminative agent,** allied to the peppers.

IRIDACEÆ.

Crocus.—Saffron. The dried stigmas and tops of the styles of Crocus sativus.

Characters.—Each entire portion is about 1 inch in length, and consists of three orange-red stigmas, thickened and tubular above, jagged or notched at the upper extremities, and united below to the top of the yellow style. Saffron is flexible and unctuous to the touch, unless quite dry; odour peculiar, strong, aromatic; taste bitter, somewhat aromatic. Rubbed on the wet finger it leaves an intense orange-yellow tint. *Impurities.*—Marigold and safflower petals, chalk, nitrates, and coloured powders. Oil; when pressed between folds of white filtering-paper it should leave no oily stain.

Composition.—Saffron contains *polychroite*, an orange-red glucoside, which yields a red colouring matter, *crocin;* also a *volatile oil*, $C_{10}H_{16}$.

Preparation.

Tinctura Croci.—Tincture of Saffron. 1 in 20 of Alcohol 60 per cent.; by maceration. *Dose*, 5 to 15 min.

Saffron is contained in: Decoctum Aloes Compositum and Tinctura Cinchonæ Composita.

USES.

Crocus is used only to **flavour and colour pharmaceutical preparations.**

Iris.—Blue Flag. (*Not official.*) The rhizome and rootlets of Iris versicolor.

Characters.—Rhizome 2 to 4 inches long; jointed; terminated by a scar; annulated from the leaf-sheaths; grey-brown. Roots long, simple. Odour slight; taste acrid nauseous.

Composition.—A substance, *iridin*, of doubtful constitution has been obtained from the rhizome.

Non-official Preparations.

Extractum Iridis (U. S. P.).—*Dose*, 1 to 5 gr. **Extractum Iridis Fluidum** (U. S. P.).—*Dose*, 5 to 60 min. **Iridin.**—A powdered extractive; dark-brown, bitter, nauseous, acrid. *Dose*, 1 to 5 gr.

ACTIONS AND USES.

Iridin is an **hepatic stimulant or direct cholagogue, and a cathartic**; possibly also diuretic. It is a useful purgative in disorders of the liver and duodenum.

SMILACEÆ.

Sarsæ Radix.—SARSAPARILLA. The dried root of Smilax ornata. Imported from Costa Rica and commonly known as Jamaica Sarsaparilla.

Characters.—Very long, nearly cylindrical, tough, flexible roots, greyish-brown or dark reddish-brown, folded together and bound with a root of the same plant into bundles 18 inches in length, and 4 or 5 inches in diameter. The roots are usually $\frac{3}{16}$ inch in thickness, deeply wrinkled longitudinally, and provided with numerous rootlets. Transverse section exhibits a reddish-brown cortex and yellowish-white wood. No odour; taste slightly bitter. *Substances resembling Sarsaparilla:* Senega; twisted and keeled. Hemidesmus, cracked transversely. *Impurities.*—Inferior kinds.

Composition.—Sarsaparilla contains a small quantity of a *volatile oil;* a colourless crystalline neutral principle, *smilacin*, closely allied to saponin; *resin*, *starch*, *mucilage*, etc.

Preparations.

1. **Extractum Sarsæ Liquidum.**—Alcoholic, with Glycerin. 2 in 1. *Dose*, 1 to 4 fl.dr.

2. **Liquor Sarsæ Compositus Concentratus.**—Concentrated Compound Solution of Sarsaparilla. Sarsaparilla, 20; Sassafras Root, 2; Guaiacum Wood, 2; Dried Liquorice Root, 2; Mezereon Bark, 1; Alcohol 90 per cent., 4·5; Distilled Water *q.s.* Concentrated to make 20. *Dose*, 2 to 8 fl.dr.

ACTIONS AND USES.

The physiological actions of Sarsaparilla are unknown, the diaphoretic and diuretic effects which follow large draughts of its fluid preparations freely diluted being possibly due to the water alone. It is tolerated in very large doses by the stomach. Smilacin is excreted in the urine.

Great diversity of opinion exists as to the therapeutical value of Sarsaparilla. Whilst the pharmacological evidence is negative, the clinical evidence is discordant, some authorities considering it a drug of extraordinary value in syphilis and chronic diseases of the skin and rheumatism, others as entirely worthless. On the one hand, many cases of these diseases are greatly benefited by general treatment, with rest, good foods, baths and abundance of warm fluids alone; on the other hand, Sarsaparilla is almost always combined with other drugs, including Guaiacum, Sassafras, Mezereon, Potassium Iodide, and Mercury. If given, it is in old standing cases of syphilis in feeble subjects, who have already suffered from the abuse of Mercury or Iodine; and the Concentrated Compound Solution should be freely used.

LILIACEÆ.

Scilla.—SQUILL. The bulb of Urginea Scilla; divested of its dry membranous outer scales, cut into slices, and dried.

Characters.—The slices of the inner scales usually present the form of curved strips, frequently tapering towards both ends; they are yellowish-white or somewhat pinkish, from about 1 to 2 inches long, somewhat translucent, brittle and easily pulverisable when quite dry, but tough and flexible when moist. Inodorous, disagreeably bitter.

Substance resembling Scilla.—Tragacanth; translucent.

Composition. — Squill yields a bitter non-nitrogenous glucoside *scillaïn*, also *scillipicrin* and *scillitoxin*, obscurely related to each other; and much *mucilage*. *Dose*, 1 to 3 gr.

Preparations.

1. **Acetum Scillæ.**—1 in 8 of Diluted Acetic Acid; by maceration. *Dose*, 10 to 30 min.

From Acetum Scillæ is prepared:

SYRUPUS SCILLÆ.—Acetum Scillæ, 20; Refined Sugar, 38. *Dose*, ½ to 1 fl.dr.

2. **Oxymel Scillæ.**—5; Acetic Acid, 5; Distilled Water, 16; Clarified Honey, *q.s.* (about 54), to give sp. gr. 1·320. *Dose*, ½ to 1 fl.dr.

3. **Pilula Scillæ Composita.**—1·25; Ginger, 1; Ammoniacum, 1; Hard Soap, 1; Syrup of Glucose, 1 or *q.s.* *Dose*, 4 to 8 gr.

4. **Pilula Ipecacuanhæ cum Scilla.**—1; Compound Powder of Ipecacuanha, 3; Ammoniacum, 1; Syrup of Glucose, *q.s.* 1 of Opium in 20. *Dose*, 4 to 8 gr.

5. **Tinctura Scillæ.**—1 in 5 of Alcohol 60 per cent.; by maceration. *Dose*, 5 to 15 min.

ACTIONS AND USES.

The actions of this important drug so **closely resemble those of digitalis** that it is unnecessary to give them in detail. The student is therefore referred to all that is said respecting Digitalis at page 364, and will apply it to Squill. Briefly, it produces the same increase of vigour and diminution of frequency of the cardiac action; the same contraction of the peripheral vessels and rise of pressure, followed by relaxation commencing in the renal arterioles; and therefore the same kind of diuresis.

Squill is employed in the same class of cases as Digitalis, and frequently in combination with that drug, diuretics being most active when given together. It must not be ordered continuously, but with intermissions, when it is more actively diuretic and less irritant to the stomach and kidneys.

Two properties, however, distinguish Squill from Digitalis, and have to be carefully observed: (1) Squill is much **more irritant to the stomach and intestines even than digitalis,** causing vomiting and purging in full doses, and is very liable to produce dyspepsia even in medicinal quantities; thus it must often be withheld when most clearly indicated.* (2) Squill is a **powerful expectorant.** This action is probably a remote local one, the scillaïn stimulating the structures in the bronchial wall during excretion, as it irritates the gastro-intestinal wall during absorption, in this respect resembling Ipecacuanha (emetine) and Senega. It is much employed as a stimulant expectorant in chronic bronchitis, where the indications are to increase the local circulation and secretion, and to accelerate the removal of the products, to strengthen the right ventricle, and to promote diuresis. It must be withheld in phthisis when the stomach and bowels are feeble or

deranged. The routine use of Squill for cough of every kind is to be deprecated.

Convallaria.—(*Not official.*) The entire plant of Convallaria majalis, Lily of the Valley.

Characters.—Leaves radical, usually two, oblong, tapering at both ends, 4 to 6 inches long. Flower-stem leafless, radical, shorter than the leaves. Flowers drooping, bell-shaped, in a loose raceme.

Composition.—Lily of the Valley contains two glucosides, *convallarin*, crystalline, insoluble in water; and *convallamarin*, white, amorphous, bitter, and soluble in water and in alcohol.

Non-official Preparations.

Extract of Convallaria.—Aqueous. *Dose*, 2 to 8 gr. **Convallamarin.**—*Dose*, $\frac{1}{2}$ to 2 gr.—A **Tincture** may also be used.

ACTIONS AND USES.

Convallaria has actions very similar to those of Squill and Digitalis: in medicinal doses it **slows and strengthens the heart, raises the blood-pressure, and is a decided diuretic.** It has proved useful in some cases of cardiac dropsy; but it is a very uncertain remedy. Like the two other drugs named, it is at the same time a gastro-intestinal irritant, this effect being due to the convallarin, whilst convallamarin acts on the circulation. Aqueous preparations and convallamarin are therefore given.

Aloe Barbadensis.—Barbados Aloes. The juice that flows from the transversely cut leaves of Aloe vera, Aloe chinensis, and probably other species; evaporated to dryness. Imported from the West Indian Islands, and known in commerce as Barbados and Curaçoa Aloes.

Characters.—In hard masses, varying from yellowish- or reddish-brown to chocolate-brown or almost black. Fracture either dull and waxy, with opaque splinters; or smooth and glassy, with transparent splinters. Opaque variety examined under the microscope exhibits numerous minute crystals embedded in a transparent mass. Odour disagreeable; taste nauseous and bitter. *Solubility.*—Almost entirely soluble in

alcohol 90 per cent. diluted with half its volume of water. Not more than 30 per cent. should be insoluble in cold water. *Impurities.*—Natal Aloes, giving a bright blue coloration if the vapour of nitric acid is blown over the powder previously mixed with sulphuric acid. *Substances resembling Aloes:* Guaiacum Resin and Resin of Jalap; destitute of bitter taste. *Dose*, 2 to 5 gr.

Aloe Socotrina.—SOCOTRINE ALOES.—The juice that flows from the transversely cut leaves of Aloe Perryi, and probably other species of Aloe; evaporated to dryness. Imported principally by way of Bombay, and known in commerce as Socotrine and Zanzibar Aloes.

Characters.—Socotrine Aloes, as imported, is usually more or less viscid and brownish-yellow, but forms, when dried, hard dark-brown, or nearly black masses that break with a dull waxy uneven fracture. Odour strong but not disagreeable; taste nauseous and bitter. Zanzibar Aloes is usually imported in liver-brown masses; the fracture dull, waxy, but nearly smooth and even; odour characteristic; taste nauseous and bitter. Both varieties are opaque even in small splinters; and exhibit when examined under the microscope numerous minute crystals embedded in a transparent mass. *Impurities.*—Barbados and Natal Aloes. *Solubility.*—Almost entirely soluble in alcohol 90 per cent. diluted with half its volume of water; about 50 per cent. should be soluble in water.

Composition.—Aloes contains: (1) The official *aloin;* (2) *aloe resin*, a brown translucent body, insoluble in water; (3) *gallic acid*, in small quantity; (4) *a volatile oil*, the source of the odour of Aloes; and various less important bodies. *Dose of either kind of Aloes*, 2 to 5 gr.

Preparations.

A. *Of Aloe Barbadensis and Aloe Socotrina:*

Aloinum. ALOIN. $C_{16}H_{16}O_7,3H_2O$.

Source.—Extracted from Barbados or Socotrine Aloes by solvents, and purified by recrystallisation.

Characters.—Tufts of acicular crystals; yellow, inodorous, having the taste of Aloes. *Solubility.*—Sparingly in cold water; more soluble in alcohol 90 per cent.; freely in the hot liquids; nearly insoluble in ether. Not readily altered in acidulated or neutral solutions; rapidly altered in alkaline liquids. As

obtained from the different varieties of Aloes, the products differ slightly; but they are isomeric in the anhydrous state, and their medicinal properties are similar. *Dose*, ½ to 2 gr.

B. *Of Aloe Barbadensis:*

1. **Extractum Aloes Barbadensis.**—Aqueous. *Dose*, 1 to 4 gr.

From Extract of Barbados Aloes are prepared:

a. DECOCTUM ALOES COMPOSITUM.—Extract, 2; Myrrh, 1; Saffron, 1; Potassium Carbonate, 1; Extract of Liquorice, 8; Compound Tincture of Cardamoms, 60; Water, to make 200 (added after cooling). *Dose*, ½ to 2 fl.oz.

b. TINCTURA ALOES.—Extract, 1; Liquid Extract of Liquorice, 6; Alcohol 45 per cent., to make 40. *Dose*, ½ to 1 fl.dr. for repeated administration; for a single dose 1½ to 2 fl.dr.

Extractum Aloes Barbadensis is also an ingredient of Extractum Colocynthidis Compositum; 1 in 2¼ nearly.

2. **Pilula Aloes Barbadensis.**—2; Hard Soap, 1; Oil of Caraway, ⅛; Confection of Roses, 1. *Dose*, 4 to 8 gr.

3. **Pilula Aloes et Ferri.**—2; Exsiccated Ferrous Sulphate, 1; Compound Powder of Cinnamon, 3; Syrup of Glucose, 3. *Dose*, 4 to 8 gr.

Barbados Aloes is also an important ingredient of: Pilula Cambogiæ Composita (1 in 6), Pilula Colocynthidis Composita (1 in 3) and Pilula Colocynthidis et Hyoscyami (1 in 4½).

C. *Of Aloe Socotrina:*

1. **Pilula Aloes Socotrinæ.**—2; Hard Soap, 1; Oil of Nutmeg, ⅛; Confection of Roses, 1. *Dose*, 4 to 8 gr.

2. **Pilula Aloes et Asafetidæ.**—Aloes, Asafetida, Hard Soap, Confection of Roses: of each, 1. *Dose*, 4 to 8 gr.

3. **Pilula Aloes et Myrrhæ.**—2; Myrrh, 1; Syrup of Glucose, 1·5. *Dose*, 4 to 8 gr.

Socotrine Aloes is also an important ingredient of: Pilula Rhei Composita, 1 in 6; and Tinctura Benzoini Composita, 1 in 60.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Aloes acts upon the stomach and intestines as a **bitter and purgative.** The former effect is fully described under *Calumbæ Radix*, page 220. As a purgative, Aloes is peculiar in **acting chiefly upon the colon.** Ten to fifteen hours, or even more, after an ordinary dose (rarely sooner), a soft, formed or slightly relaxed motion is passed. Very large doses may not act more quickly, but much more violently, with pain, straining and possibly bleeding from the rectum. Aloes is thus the slowest of all purgatives. The presence of bile is believed to be required to ensure the action of the purgative Aloin, and the drug is, in turn, a stimulant of the biliary flow. The pelvic circulation generally, as well as that of the rectum, is excited by Aloes, which may cause hæmorrhoids and hæmorrhage from the bowel, **increased uterine activity, menstruation,** possibly menorrhagia, and even abortion, if it be given in large doses, to certain subjects, or too frequently.

Aloes is used as one of our most valuable purgatives in suitable cases. It is especially indicated in habitual constipation due to languor of the colon, with atonic dyspepsia and hypochondriacal despondent feelings. It improves instead of deranging digestion, and gains instead of losing in activity by repetition ; its laxative effect, too, is of a natural character, if its griping action be covered with carminatives as in most of the official preparations. It must, however, be avoided in irritable states of the rectum, hæmorrhoids, menorrhagia and pregnancy, unless it be given with special care. Aloes is an ingredient of almost all the compound pills in ordinary use for habitual constipation, those *e.g.* of Rhubarb, Colocynth and Gamboge ; and the Extract is also given with Extract of Belladonna, Nux Vomica, Ferrous Sulphate or Quinine, as a dinner-pill. The Compound Decoction is perhaps the best preparation, being particularly valuable in the constipation of children with hard motions, worms, indigestion and derangement of health as a whole.

The action of Aloes on the pelvic circulation constitutes it a uterine stimulant, and it is given with success as the Aloes and Myrrh Pill in the amenorrhœa of young women, so often associated with chronic constipation and dyspepsia, The Aloes and Iron Pill is probably the most valuable of all remedies in the anæmia, amenorrhœa and constipation of girls at and after puberty. An enema of Aloes is **anthelmintic.**

2. ACTIONS IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

Aloin enters the blood and tissues, and is excreted at least in the milk.

Veratrina.—VERATRINE. ($C_{37}H_{53}NO_{11}$?).—An alkaloid or mixture of alkaloids prepared from Cevadilla, the dried ripe seeds of Schœnocaulon officinale.

Source.—May be obtained by (1) making and concentrating a tincture of the seeds of Cevadilla; (2) pouring it into water to precipitate resins, and filtering; (3) precipitating crude Veratrine from the filtrate by Ammonia, and washing; (4) purifying by solution in HCl, digestion with charcoal, reprecipitation with Ammonia, filtration, washing and drying.

Characters.—Pale grey, amorphous; odourless, but powerfully irritant to the nostrils; strongly and persistently bitter; intensely acrid. *Solubility.*—Insoluble in water; soluble 1 in 3 of alcohol 90 per cent. or of chloroform; 1 in 6 of ether; and in diluted acids. With H_2SO_4 forms a deep-red solution exhibiting a yellowish-green fluorescence by reflected light. Warmed with HCl, it dissolves, with production of a blood-red colour.

Preparation.

Unguentum Veratrinæ.—1; Oleic Acid, 4; Lard, 45.

ACTIONS AND USES.

1. LOCAL ACTIONS AND USES.

Externally.—Veratrine is **first a powerful irritant and then a depressant** to the nerves and vessels, causing pricking burning sensations and redness of the skin, followed by loss of sensibility and vesication. Unguentum Veratrinæ is therefore applied to relieve neuralgic and rheumatic pains; but the alkaloid is absorbed by the unbroken skin, and may produce its powerful specific effects.

Inhaled or sniffed into the nose, this substance causes violent sneezing and cough, manifestly by irritation of the nerves. No use is made of this property.

Internally, reflex salivation, dysphagia, epigastric heat and pain, vomiting and diarrhœa are manifestations of the irritant effect of Veratrine on the alimentary canal.

2. ACTIONS ON THE BLOOD.

Veratrine enters the blood rapidly from the skin or mucous surfaces. Leucocytes (in drawn blood) are paralysed or killed by dilute solutions of the alkaloid.

3. SPECIFIC ACTIONS AND USES, AND REMOTE LOCAL ACTIONS.

Veratrine may be found in the various organs after administration. Full doses produce, in addition to the painful vomiting of local origin, great muscular prostration, faintness, and finally collapse, preceded and accompanied by a slow, feeble or irregular pulse, feeble respiration, cold sweats, fall of temperature, occasional muscular twitching, and creeping and itching sensations on the skin. It has now been proved that these phenomena are not referable to the *cerebrum*, which remains unaffected, with perfect consciousness; nor to the motor centres of the *cord*, nor to the *motor* nerves, all of which are but slightly depressed. **The muscles are the organs attacked by veratrine,** which produces a highly remarkable lengthening of the contraction, the descending portion of the muscle curve (phase of relaxation) being fifty times its ordinary extent. Therewith the force of the contraction is increased. These two effects are so marked that the muscle appears to be in a state of tetanus, but the curve is really a single contraction, and not a fusion of closely repeated simple spasms. Larger doses cause weakness of the muscles and finally paralysis.

The heart, after primary acceleration, is affected just like the voluntary muscles, its contractions becoming greatly lengthened, and thus its **frequency reduced** (even by 20 to 60 beats per minute in fever), long pauses occurring at the end of systole. Irregularity, acceleration with feebleness and finally paralysis are the results of larger doses. The *blood-pressure* rises at first, falls during the stage of infrequency, and is then dangerously lowered. The primary stimulation of the heart and vessels, and part of the succeeding depression, occur through the centres in the medulla. *Respiration* is first accelerated, then slowed, and finally arrested through the centre, the muscles, and the pulmonary vagus; the movements exhibiting expiratory pauses and irregularity. The fall of *temperature*, which may amount to several degrees in fever, appears to be referable to the circulatory failure.

The specific uses of Veratrine depend on its depressing

action on the heart, vessels and body temperature: that is, it is a powerful **antipyretic.** It has been recommended for the same conditions as Aconite, namely, acute febrile processes in strong subjects, such as sthenic pneumonia and acute rheumatism. If it be considered safe and desirable to treat such cases with powerful depressant measures, Veratrine may be used; but in England, at least, the opposite line of treatment is generally followed, and every lowering influence on the heart carefully avoided.

Veratrine quickly appears in the urine, being excreted by the kidneys unchanged.

Colchici Cormus.—Colchicum Corm. The *fresh* corm of Colchicum autumnale, collected in early summer; and the same stripped of its coats, sliced transversely, and *dried* at a temperature not exceeding 150° F.

Characters.—Fresh corm about $1\frac{1}{2}$ inch long, 1 inch broad, conical, hollowed on one side, rounded on the other. Outer coat thin, brown, membranous; inner reddish-yellow. Internally white, solid, yielding a milky juice of a bitter taste and disagreeable odour. *Dried* slices $\frac{1}{10}$ or $\frac{1}{8}$ inch thick, yellowish at circumference, somewhat reniform in outline; firm, whitish, amylaceous; fracture short; no odour; taste bitter. *Substances somewhat resembling Colchicum:* Tragacanth and Squill, which have different textures, and are not kidney-shaped. *Incompatibles.*—Tincture of Iodine, Guaiacum, and all astringent preparations. *Dose of the dried corm*, 2 to 5 gr.

Colchici Semina.—Colchicum Seeds. The dried, ripe seeds of Colchicum autumnale.

Characters.—About $\frac{1}{10}$ inch in diameter, subglobular-pointed at the hilum; reddish-brown; rough, minutely pitted, very hard and tough. No odour; taste bitter, acrid; endosperm oily. *Substance resembling Colchicum Seeds:* Black Mustard, which is smaller.

Composition.—Colchicum contains an amorphous, yellowish, bitter alkaloid, *colchicine*, $C_{17}H_{91}NO_5$, readily soluble in water and spirit; a trace of *veratrine;* tannic and gallic acids, starch, sugar, gum, etc.

Preparations.

A. *Of Colchici Cormus:*

1. **Extractum Colchici.**—Made from the *fresh* corm. (*See* p. 13 (*d*)). *Dose*, $\frac{1}{4}$ to 1 gr.

2. **Vinum Colchici.**—1 of *dried* Corm in 5 of Sherry; by maceration. *Dose*, 10 to 30 min.

B. *Of Colchici Semina*:

Tinctura Colchici Seminum.—1 in 5 of alcohol 45 per cent.; by percolation. *Dose*, 5 to 15 min.

ACTIONS AND USES.

The physiological actions of Colchicum are imperfectly understood, and afford but a partial explanation of its empirical use.

Internally it is a **gastro-intestinal irritant,** acting as an emetic and purgative in full doses, the stools containing a decided increase of bile, partly referable to a **direct cholagogue** effect of the drug. Colchicine appears to enter the blood and tissues, and to act chiefly upon the central nervous system. The convolutions and spinal cord are depressed, large doses causing loss of sensibility and consciousness, and diminishing reflex excitability. The peripheral sensory nerves are also paralysed; the motor nerves and muscles remain unaffected. The respiratory centre is lowered in activity, and death occurs by asphyxia. The heart is weakened, the pulse even becoming intermittent; but this effect is believed to be entirely secondary to the disturbance of the respiration. The kidneys are hyperæmic; the amount of urine, uric acid and urea are occasionally, but not certainly, increased in quantity. The **skin perspires.**

Colchicum is chiefly used **to relieve** the pain and inflammation, and shorten the duration, of **acute gout,** for which purpose it is usually given in doses capable of producing some of the above physiological effects, including an increased excretion of uric acid. It is most successful in first attacks in young robust subjects; it is less useful, and to be used with caution, in the chronic gout of old or weakly individuals; occasionally it completely fails to afford relief. It is generally prescribed as the Vinum with alkaline purgative salines. In some acute gouty affections of other parts than the joints, such as bronchitis, hepatic congestion, neuralgia and urethritis, Colchicum occasionally relieves. It is worse than useless in rheumatism. The Extract may be added to purgative pills as a cholagogue.

GRAMINACEÆ.

Amylum.—Starch. The starch procured from the grains of common Wheat, Triticum sativum; Maize, Zea Mays; and Rice, Oryza sativa.

Characters.—In fine powder or in irregular, angular or columnar masses, which are readily reduced to powder; white; inodorous. Lightly rubbed in a mortar with a little cold water, the mixture is neither acid nor alkaline to test-papers. Boiled with water and cooled, it gives a deep blue colour with solution of iodine. Under the microscope the several varieties of starch present the following characters:—(1) *Wheat Starch:* A mixture of large and small granules, lenticular, marked with faint concentric striæ surrounding a nearly central hilum. (2) *Maize Starch:* Granules more uniform in size, frequently polygonal, somewhat smaller than the large granules of wheat starch, having a very distinct hilum but no evident concentric striæ. (3) *Rice Starch:* Granules extremely minute, nearly uniform in size, polygonal, without evident hilum or striæ. *Impurity.*—Potato starch, distinguished microscopically.

Preparation.

Glycerinum Amyli.—2; Glycerin, 13; Water, 3; gently heated. A jelly-like preparation.

Amylum is also contained in Pulvis Tragacanthæ Compositus.

ACTIONS AND USES.

Starch, a **nutritive** material of the first order, is introduced into the Pharmacopœia chiefly for pharmaceutical purposes. *Externally* it is **protective and absorbent,** in the form of "dusting powder" for delicate or diseased conditions of the skin. The Glycerinum is an excellent basis for some ointments, and a protective in chapped conditions of the skin. *Internally* a mucilage forms a convenient **vehicle** for enemata. It is also an **antidote** in poisoning by iodine, but must be followed by an emetic.

Malt Extract.—Extractum Malti. *Not official.* A syrupy yellowish-brown fluid, with a sweet taste; made by acting on malt, or a mixture of malt and flour, by water at a temperature not exceeding 124° F.

Composition.—Malt Extract consists chiefly of *maltose; dextrin; albumens*, including an active ferment *diastase;* and the soluble phosphates of the barley. Good specimens have active diastasic properties, *i.e.* will convert several times their bulk of starch into sugar. *Dose*, 1 to 4 dr.

ACTIONS AND USES.

Malt Extract is both directly and indirectly nutritive, containing, as it does, not only food elements, but also active diastase, which converts the starch of bread and other farinas into sugar. It is used in wasting diseases. As diastase is most active in alkaline fluids, Malt Extract should be given not less than two hours after a meal, when the acid of the stomach is exhausted; or it may be mixed with warm food a short time before the latter is taken. Maltose is a form of sugar which does not readily give rise to acidity and dyspepsia. Malt Extract is a very good vehicle for various insoluble or nauseous drugs, such as Guaiacum, Liquid Extract of Cascara, Copaiba, Indian Hemp and Cod Liver Oil.

Ergota.—ERGOT. The sclerotium of Claviceps purpurea, originating in the ovary of Secale cereale, the Rye.

Characters.—Subcylindrical, tapering, curved; ⅓ to 1½ inch long; longitudinally furrowed on each side, especially the concave; cracked; very dark violet-black without, pinkish-white within; fracture short. Odour peculiar, disagreeable, especially if it be triturated with solution of potassium hydroxide; taste of powder disagreeable. *Impurities.*—Musty specimens.

Composition.—Ergot is believed to contain four important bodies: (1) *sphacelinic acid*, a non-nitrogenous, resinous-looking, very hygroscopic, unstable body, insoluble in water, soluble in alcohol; its alkaline salts soluble in water, but readily decomposed; (2) *cornutine*, a brown-grey, amorphous alkaloid; (3) *ergotinic acid*, a glucoside; (4) *sclerotic* or *sclerotinic acid*, a faintly-brown, amorphous, hygroscopic acid principle, soluble in water. Besides these there occur in Ergot 30 per cent. of a *fixed oil*, *colouring matter*, trimethylamin, mannite, abundance of potassium salts, and several unimportant alkaloids. *Dose*, 20 to 60 gr.

Preparations.

1. **Extractum Ergotæ.**—Extract of Ergot. Ergotin. Made by exhausting by percolation with Alcohol 60 per cent.; evaporating percolate; adding water, and

filtering; adding diluted hydrochloric acid, and filtering; adding sodium carbonate, and evaporating. *Dose*, 2 to 8 gr.

From Extractum Ergotæ is prepared:

Injectio Ergotæ Hypodermica.—Hypodermic Injection of Ergot. Hypodermic Injection of Ergotin. 10; Phenol, ·3; Distilled Water to make 33; boil. 3 gr. of Extract in 10 minims. Should be recently prepared. *Dose*, hypodermically, 3 to 10 min.

2. **Extractum Ergotæ Liquidum.**—1 in 1. Aqueous, with Alcohol 90 per cent. added. *Dose*, 10 to 30 min.

3. **Infusum Ergotæ.**—1 in 20 of boiling Water. *Dose*, 1 to 2 fl.oz.

4. **Tinctura Ergotæ Ammoniata.**—5; Solution of Ammonia, 2; Alcohol 60 per cent., to make 20; by percolation. *Dose*, ½ to 1 fl.dr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

In large doses Ergot is a gastro-intestinal irritant, but moderate doses may be given almost indefinitely without disturbing the stomach or bowels. Most of the ergotinic acid is either decomposed in the intestine into an inert substance and glucose, or escapes unabsorbed by the bowel.

2. ACTIONS IN THE BLOOD, AND SPECIFIC ACTIONS.

The active principles of Ergot which enter the blood produce no appreciable change on it. Thence they pass into the tissues and organs, and set up well-marked symptoms, if given in full doses for a sufficient time. The parts chiefly affected are the circulation, central nervous system, respiration, intestines and uterus. **The arteries become distinctly smaller** under Ergot. Pure sphacelinic acid causes powerful contraction of the walls of the arterioles, followed in animals by degeneration. **The blood-pressure rises. The heart is reduced in frequency** by Ergot, sometimes twenty to thirty-six beats per minute, and becomes feeble and irregular at last, apparently through the vagus. With respect to the nervous system, the highest centres (cerebral) are not directly influenced by Ergot; possibly the circulation may be disturbed in the brain. **The spinal cord is markedly affected, a**

series of nervous phenomena being the result. The patient first complains of creeping sensations in the limbs, as if an insect were running along the skin; sudden painful cramps or twitchings of the legs follow; the gait becomes staggering (ataxic); and convulsions, with loss of sensibility and motion, may ensue. These spinal effects are chiefly seen in cases of chronic "ergotism," where the drug has been consumed in large quantity in rye bread; they may be met with clinically; and appear to be referable partly to vascular disturbance or disease, partly to the depressing action of ergotinic acid, degenerative changes being found in the posterior (Burdach's) columns after death. Cramps and rigidity of the muscles are induced by cornutine. Respiration becomes infrequent after large doses of Ergot; death occurs by asphyxia. The intestine is peculiarly blanched under Ergot, and consequently excited to peristaltic movements. **The uterus** becomes similarly anæmic and **contracts actively,** especially if pregnant, and still more if parturition have commenced, when long and powerful pains are developed. The effects of Ergot on the bowels and womb have also been referred to stimulation of their spinal centres: they are certainly due to the action of the sphacelinic acid and cornutine; not to that of the ergotinic acid. The body temperature falls. Gangrene frequently results from the protracted use of ergotised meal as an article of diet; and it can be readily induced by administering sphacelinic acid to animals. Ergotinic acid has a moderately dilating influence on the vessels.

3. SPECIFIC USES.

Ergot is used chiefly to control hæmorrhage, and to excite or increase uterine contractions. As a **hæmostatic,** acting apparently by slowing the heart, contracting or even closing the arterioles, and thus promoting coagulation within them, it is extensively employed in hæmoptysis, hæmatemesis and menorrhagia, either as the Liquid Extract or Ammoniated Tincture given by the mouth, or as the Hypodermic Injection.

The use of Ergot in the second stage of labour should be confined to cases of uterine inertia where there is no obstacle in the passages: so frequently is this **ecbolic** abused, that it is calculated that more harm than good has resulted from the discovery of its action in parturition. After the completion of the second stage, Ergot may be more safely given, to expel the placenta and clots, and ensure contraction of the womb; whilst in *post-partum* hæmorrhage it is an invaluable adjuvant to more immediate remedies. In polypus

uteri, chronic metritis, sub-involution, etc., Ergot is also used with success.

The action of Ergot on the spinal cord suggests its rational application in paraplegia of inflammatory origin, sclerosis, etc., and instances of recovery under its influence are recorded. It has also been used in chorea, general paralysis and recurrent mania referable to cerebral hyperæmia.

4. REMOTE LOCAL ACTIONS AND USES.

Ergot **reduces the amount of the urine, sweat and milk,** more probably by affecting the local blood-pressure and the gland centres in the brain and spinal cord, than by a direct action on the excreting cells. It is a valuable remedy in some cases of polyuria (diabetes insipidus), very rarely in saccharine (true) diabetes. The sweats of phthisis are said to be controlled by Ergot. As an antigalactagogue it is but seldom employed.

5. ACTIONS AND USES OF THE CONSTITUENTS OF ERGOT.

These have been indicated in the preceding description. Ergotinic acid appears to be useless. Sphacelinic acid promises to become a valuable hæmostatic and ecbolic. The action of cornutine is but imperfectly known.

Saccharum Purificatum.—REFINED SUGAR. Sucrose. $C_{12}H_{22}O_{11}$. *Source.*—Obtained from the juice of the sugar cane.

Characters.—Familiar. *Solubility.*—2 in 1 of water. It increases the solubility of lime in water; see *Liquor Calcis Saccharatus*, page 56.

Preparation.

Syrupus.—1 in 1·5 of boiling Water; with the aid of heat. Sp. gr. 1·330.

From Syrup is prepared:

SYRUPUS GLUCOSI.—**Syrup of Glucose. 2;** Liquid glucose of commerce, 1.

Refined Sugar or Syrup is also contained in all the official Syrups and in many other preparations.

ACTIONS AND USES.

Sugar is **nutritive and demulcent,** but in medicine is chiefly used to cover the taste of other drugs. Syrup of Glucose forms an excellent neutral excipient for pills.

FILICES.

Filix Mas.—MALE FERN. The rhizome of Aspidium Filix mas. Collected late in the autumn, divested of its roots, leaves and dead portions, and carefully dried.

Characters.—Three to 6 inches or more long, the rhizome itself from ¾ to 1 inch in diameter. Entirely covered with the hard, persistent, curved, angular, dark-brown bases of the petioles, which bear numerous brown, membranous scales. Rhizome brown externally, green internally. Bases of the petioles also green internally. Odour feeble but disagreeable; taste sweetish and astringent at first, subsequently bitter and nauseous.

Composition.—Male Fern contains a colourless crystalline body, *filicic acid*, $C_{14}H_{18}O_5$, *fixed* and *volatile oils*, *tannic acid* and *resins*. Which of these may be the active principle is uncertain.

Preparation.

Extractum Filicis Liquidum.—Liquid Extract of Male Fern. An oily extract made by percolating with Ether, and then evaporating or distilling off the Ether. *Dose*, 45 to 90 min. (in emulsion with mucilage or Tincture of Quillaia).

ACTION AND USE.

Male Fern is an active **anthelmintic**, peculiarly destructive to the tape-worm. It is less irritant to the stomach and bowels than Kousso, and should be administered fasting, preceded if necessary, and always followed, by a purgative, such as Castor Oil. On the whole, it is the most successful of anthelmintics when properly employed.

GROUP II.

THE ANIMAL KINGDOM.

Moschus.—Musk. The dried secretion from the preputial follicles of Moschus moschiferus.

Characters.—In irregular dark reddish-brown or reddish-black, rather unctuous grains ; odour characteristic, persistent, penetrating ; taste somewhat bitter. Contained in a roundish or oval sac about 1½ to 2 inches in diameter, nearly smooth on one side, covered on the other or outer side with appressed bristle-like brownish-yellow or greyish hairs concentrically arranged around a central orifice.

Composition.—Musk contains an *aromatic principle*, the chemical nature of which is unknown, and a quantity of inactive substances, such as salts, fixed oils, etc. *Dose*, 5 to 10 gr. (in a pill or with Pulvis Tragacanthæ Compositus).

ACTIONS AND USES.

Musk is a powerful stimulant of the circulatory and nervous systems, acting probably much like Turpentine and other volatile oils, *i.e.* chiefly reflexly from the nose, mouth and stomach. It appears to enter the blood and tissues, where it rapidly causes depression, so that in full doses its stimulant effect is extremely evanescent. The drug may be used as an antispasmodic, or as a stimulant in fevers and pneumonia.

Sevum Præparatum.—Prepared Suet. The internal fat of the abdomen of the sheep, Ovis Aries, purified by melting and straining.

Characters.—White, smooth, almost odourless; fusible at 112° to 120° F. *Solubility.*—Freely soluble in petroleum spirit, slowly in benzol; slightly in ether or boiling alcohol 90 per cent.; insoluble in cold alcohol 90 per cent.

Composition.—Suet is composed of *olein* and *stearin*. See *Adeps*, page 434.

Suet is contained in Unguentum Hydrargyri.

ACTIONS AND USES.

Suet is **emollient** externally; internally it is **nutritive**.

Sapo Animalis.—CURD SOAP. Soap made with Sodium Hydroxide and a purified animal fat consisting principally of stearin. Contains about 30 per cent. of water.

Characters.—White or light-greyish; nearly inodorous horny and pulverisable when dry, plastic when heated. *Solubility.*—Soluble in alcohol 90 per cent.; sparingly in cold, but soluble in hot, water; the solution being neutral or faintly alkaline.

Composition.—The chemical relations of soaps are described at pages 336 and 338. *Impurities.*—Excess of alkaline hydroxide or carbonate; free oil; free fat; potassium soap.

Curd Soap is contained in Extractum Colocynthidis Compositum, Linimentum Potassii Iodidi cum Sapone, and Pilula Scammoniæ Composita.

ACTIONS AND USES.

These are described in connection with Hard and Soft Soaps, at page 337.

Adeps Lanæ.—WOOL FAT. The purified cholesterin fat of sheep's wool.

Characters.—Yellowish, tenacious, unctuous; nearly inodorous; melting-point, 104° to 112° F. *Solubility.*—Readily in ether or chloroform; sparingly in alcohol 90 per cent.

Preparation.

Adeps Lanæ Hydrosus.—Hydrous Wool Fat, 7; Water, 3; intimately mixed.

Hydrous Wool Fat is contained in **Unguentum Conii and** Unguentum Hamamelidis.

ACTIONS AND USES.

Hydrous Wool Fat forms a valuable **basis for certain ointments**. It is non-irritant; and being readily absorbed, may be used as a vehicle for iodine, potassium iodide, morphine, quinine and other drugs.

Saccharum Lactis.—Milk Sugar. Lactose. $C_{12}H_{22}O_{11}$, H_2O. *Source.*—Obtained from the whey of Milk.

Characters.—In crystals or in crystalline masses, greyish-white, hard; odourless, faintly sweet. *Impurity.*—Excess of lactic acid. *Solubility.*—1 in 7 of cold, and 1 in about 1 of boiling, water. *Substance resembling Milk Sugar:* Acid Potassium Tartrate; known by taste, and without central cord.

Saccharum Lactis is an ingredient of Pulvis Elaterini Compositus, Extractum Belladonnæ Alcoholicum, Extractum Nucis Vomicæ, Extractum Opii, Extractum Physostigmatis, and Extractum Strophanthi.

ACTIONS AND USES.

Milk Sugar is a suitable **vehicle** for powders. It is also used to sweeten preparations of milk for artificially-fed infants. In doses of 3 ounces *per diem* it is **diuretic**.

Fel Bovinum Purificatum.—Purified Ox Bile.

Source.—Made by evaporating 1 pint of fresh Ox Bile to $\frac{1}{4}$ its volume; shaking it with $\frac{1}{2}$ pint of alcohol (90 per cent.): setting the mixture aside to subside; decanting the clear solution, filtering the remainder, washing the filter and contents with a little more alcohol, distilling off most of the alcohol from the mixed liquids, and evaporating the residue until it acquires the consistence of a thick extract.

Characters.—A yellowish-green hygroscopic substance; taste partly sweet, partly bitter. Soluble in water, and in alcohol 90 per cent. Gives the colour test for the bile acids. *Impurity.*—Mucus, giving a precipitate with alcohol in watery solution.

Composition.—Purified Ox Bile has the composition of fresh bile, less the mucus removed by the alcohol. *Dose*, 5 to 15 gr.

ACTIONS AND USES.

The action of Bile in the duodenum is familiar. When it is admitted into the stomach it is apt to cause vomiting, neutralising the gastric juice, precipitating the pepsin, and being itself rendered inactive. It is a bitter and **cholagogue purgative** of doubtful value.

Gelatinum.—GELATIN. The air-dried product of the action of boiling water on such animal tissues as skin, tendons, ligaments and bones.

Characters.—In translucent and almost colourless sheets or shreds. A solution in 50 parts of hot water is inodorous, and solidifies to a jelly on cooling. *Solubility.*—Soluble in water and in acetic acid; insoluble in alcohol 90 per cent. and ether. Aqueous solution is precipitated by solution of tannic acid; not by diluted acids, solutions of alum or of lead acetate, or solution of ferric chloride.

Gelatin is an ingredient of Suppositoria Glycerini and all the Lamellæ.

ACTIONS AND USES.

Gelatin is used to **stiffen** preparations. A gelatin **basis** is useful in certain forms of eczema and other affections of the skin. A 2 per cent. solution in normal saline is injected interstitially in aneurysm.

Pepsinum.—PEPSIN. An enzyme obtained from the mucous lining of the fresh and healthy stomach of the pig, sheep, or calf.

Characters.—A light yellowish-brown or white powder, or pale-yellow translucent grains or scales; odour faint; taste slightly saline, free from any trace of putrescence; liable to absorb moisture from the air. *Solubility.*—Moderately in water; 1 in 100 of alcohol 90 per cent. Dissolves, with water acidulated with Hydrochloric Acid, 2500 times its weight of hard-boiled white of eggs. *Dose*, 5 to 10 gr.

Preparation.

Glycerinum Pepsini.—80; Hydrochloric Acid, 10; Glycerin, 525; Distilled Water, to make 875. 5 gr. in 1 fl.dr. *Dose*, 1 to 2 fl.dr.

ACTIONS AND USES.

Pepsin is extensively used as an **aid to digestion**, whether given during or after meals, alone in the solid form or combined with Hydrochloric Acid; or whether employed to peptonise food before it is taken. It is especially indicated and successful in morbid conditions of the stomach associated with deficiency of the gastric juice, from disease of the follicles, such as atrophy or dilatation; from excess of mucus, as in the chronic catarrhal dyspepsia of alcoholism, etc.; from deficient blood supply, as in anæmia and general debility; or from irritable states of the stomach with pain and vomiting, such as ulcer and cancer, where the normal stimulation of the mucous membrane must be avoided and fluid food only given. Pepsin is also useful in the dyspepsia of the aged and of infants. It must not be ordered indiscriminately, lest the gastric functions become weaker instead of more active, from want of exercise.

Pepsin is a valuable **addition to nutrient enemata**, the natural digestive power of the secretion of the rectum being comparatively small.

Liquor Pancreatis.—Pancreatic Solution. A liquid preparation containing the digestive principles of the fresh pancreas of the pig; most active when the animal has been fed shortly before being killed.

Source.—Prepared by digesting in a closed vessel, in 4 parts by volume of Alcohol 20 per cent., for seven days, one part by weight of the pancreas, freed from fat and external membrane and finely divided by trituration with washed sand or powdered pumice stone; and then filtering.

Test.—If 2 cc. of the Solution, together with 0·2 gramme of sodium bicarbonate and 20 cc. of water, be added to 80 cc. of milk, and the mixture be kept at a temperature of 113° F. for one hour, coagulation no longer occurs on the addition of nitric acid.

ACTIONS AND USES.

Preparations of the Pancreas are active digestants of proteids, fats, and amyloids, and are used with great success to peptonise milk, gruel and soups before administration in cases of digestive debility and in disease of the bowels.

Suprarenal Body.—(*Not official.*) Prepared from the suprarenal gland of the sheep. *Dose*, 15 gr.

SUPRARENAL EXTRACT.—Prepared with glycerin, and sterilised. *Dose*, 5 to 15 min.

Composition.—The active principle, probably basic, has been variously named *Adrenalin*, *Epinephrin*, etc.

ACTIONS AND USES.

Locally applied, Suprarenal Extract produces ischæmia, pallor, and dryness of mucous surfaces by vasor contraction; and a 5 to 10 per cent. solution is used before operations on these parts and in epistaxis, coryza and hay fever. Given, in animals, by intravenous or hypodermic injection, it causes rapid, great but brief rise of blood-pressure by direct vaso-motor contraction, whilst the cardiac centre and myocardium are stimulated and the heart is slowed. The vasor constriction arrests hæmorrhage; and this substance is used in bleeding from different parts, in purpura, and in hæmophilia. The contraction of skeletal muscles is greatly lengthened, suggesting its use as a tonic. Suprarenal Body has naturally been employed in Addison's disease, but with limited success.

Thyroideum Siccum.—DRY THYROID.

Source.—The fresh and healthy thyroid gland of the sheep.

Characters.—A light, dull-brown powder; odour and taste very faint, meat-like; free from flavour of putrescence; liable to become damp on exposure to the air, and then deteriorates.

Composition.—Thyroid material is of very complex composition. The active principle is a substance in organic combination with iodine 9·3 per cent., along with 0·56 per cent. of phosphorus, and known as *iodothyrin*. *Dose*, 3 to 10 gr.

Liquor Thyroidei.—THYROID SOLUTION. Prepared from the fresh and healthy thyroid gland of the sheep.

Characters.—A pinkish turbid liquid, entirely free from odour of putrescence. It must be freshly prepared, and kept in well-stoppered bottles. 100 minims represent one entire thyroid gland. *Dose*, 5 to 15 minims (twice a day).

ACTIONS AND USES.

The actions of Thyroid have been chiefly studied in **myxœdema and sporadic cretinism,** two diseases that are associated with disease or defect of the thyroid gland. Under the influence of the official preparations, or of Thyroid in other forms (for example, when it is eaten as food, or an extract is injected under the skin), all the morbid characters of myxœdema or of cretinism steadily disappear, and the subjective and mental condition of the patient improves correspondingly. It has been ascertained by careful observation that whilst Thyroid is being taken, the oxydation processes of metabolism are increased; the body-weight falls at first in consequence of removal of water and fat, but rises afterwards as health is restored; the elimination of urinary water and urea is largely augmented; and nutrition as a whole, growth, and development are roused to fresh activity. Patients taking Thyroid have, therefore, to be freely supplied with nitrogenous food. Excessive doses of this powerful agent cause pyrexia, headache, pains in the limbs, palpitation of the heart, and the appearance (or aggravation) of glycosuria, as well as gastro-enteric irritation probably referable to putrescence of the preparation employed.

Other diseases that are occasionally or temporarily benefited by the use of Thyroid are psoriasis, ichthyosis, lupus, obesity and the more acute forms of goitre.

Antitoxins, Antibacterial Serums and Vaccines.—(*Not official.*)

1. **Diphtheria Antitoxin.**—The serum of the blood of the horse, immunised by repeated injections of diphtheria toxin from cultures of the bacillus.

2. **Septicæmia Serum.** — ANTI-STREPTOCOCCUS SERUM. A serum similarly prepared from cultures of streptococcus injected into the horse.

3. **Rabies Antitoxin.**—An emulsion prepared from the spinal cords of rabbits inoculated with the virus from a rabid animal.

4. **Tetanus Antitoxin.**—An antitoxin serum prepared by injecting animals with cultivations of the tetanus bacillus.

5. **Antivenomous Serum.**—ANTIVENIN. An antitoxin prepared by immunising the horse with injections of snake poison.

6. **Antityphoid Vaccine.**—An emulsion in sterile broth of a cultivation of the typhoid bacillus.

7. **Tuberculins.**—Substances derived from media in which tubercle bacilli are grown or from the bodies of the bacilli, or a combination of the two.

Characters.—The strength of antitoxins is estimated in *units* ascertained by experiments on animals with individual specimens. They are obtained and *standardised* by inoculating animals with gradually increasing doses of toxins, or of cultivations of bacteria, until a serum is reached which renders inert, say, ten times the fatal dose of toxin as tested on a guinea-pig of a given weight. Different standards are adopted by different makers; and the strength and dose of a preparation must always be known before it is employed.

ACTIONS AND USES.

Antitoxins are used: (1) as remedial agents, in persons suffering from the like diseases, respectively; or (2) as preventive or protective agents, with persons exposed to the several infections but not yet invaded. Administration is by hypodermic injections with a special syringe, *strict asepsis being observed.*. They are given freely and as soon as possible; and are repeated at short intervals if necessary.

Diphtheria antitoxin is extensively used and most successful; the mortality from the disease being markedly reduced by it. The results obtained with *Anti-streptococcus* serum are still uncertain. *Rabies* antitoxin has prevented hydrophobia in many persons bitten by rabid dogs. *Tetanus* antitoxin is prophylactic but seldom curative. *Antivenin* both protects and cures animals bitten by certain snakes. The value of *Antityphoid Vaccine* and of the different *Tuberculins* is still unsettled. Eruptions and arthritis, which may follow serum injections, appear to be caused by peculiar bodies in the serum of the horse.

Adeps.—LARD. Purified fat of the Hog, Sus scrofa.

Characters.—A soft white fatty substance, melting at about 100° F. Neutral. Has no rancid odour. Dissolves entirely in ether. *Impurities.*—Common salt and starch.

Composition.—Lard consists of 60 per cent. of *olein* and

stearin, with some *palmitin*. Olein, $C_3H_5(C_{18}H_{33}O_2)_3$, is a *fluid* oil, a compound of oleic acid, $C_{18}H_{33}O_2$, and glyceryl, C_3H_5. Palmitin and stearin are *solid* oils, compounds of glyceryl with palmitic acid, $HC_{16}H_{31}O_2$, and stearic acid, $HC_{18}H_{35}O_2$, respectively (*see* page 336).

Preparation.

Adeps Benzoatus.—Lard, 50; Benzoin, 1·5.

Lard is contained in Emplastrum Cantharidis and Pilula Phosphori; *Benzoated Lard in:* Unguenta Belladonnæ, Cantharidis, Chrysarobini, Gallæ, Hydrargyri Iodidi Rubri, Hydrargyri Oleatis, Hydrargyri Subchloridi, Potassii Iodidi, Staphisagriæ, Sulphuris, Sulphuris Iodidi, Zinci.

ACTIONS AND USES.

Lard is a simple **emollient**, forming the basis of many of the official ointments. Benzoated Lard does not become rancid like the other, which for the same reason is now in a measure replaced by Paraffin.

Cetaceum.—SPERMACETI. A concrete fatty substance, obtained, mixed with oil, from the head of the Sperm Whale, Physeter macrocephalus. It is separated from the oil by filtration and pressure, and purified.

Characters.—Crystalline, pearly white, glistening, translucent, slightly unctuous to the touch; with little taste or odour; powdered by addition of a little alcohol 90 per cent.; melts at 114·8° to 122° F. *Soluble* in ether, chloroform, or boiling alcohol 90 per cent., and in fixed and volatile oils; insoluble in water, and nearly so in cold alcohol 90 per cent. *Substance resembling Spermaceti:* White Beeswax, known by general appearance and hardness.

Composition.—Spermaceti is a fat, *cetin*, $C_{16}H_{33}C_{16}H_{31}O_2$, containing not glyceryl but *cetylic alcohol*, $C_{16}H_{33}OH$, in combination with *palmitic acid*, $HC_{16}H_{31}O_2$.

Preparation.

Unguentum Cetacei.—5; White Beeswax, 2; Benzoin, ½; Almond Oil, 18.

Cetaceum is used in preparing Unguentum Capsici and Unguentum Aquæ Rosæ.

ACTIONS AND USES.

Spermaceti is an emollient, and is also employed for pharmaceutical purposes.

Oleum Morrhuæ.—Cod-Liver Oil. The oil extracted from the fresh liver of the cod, Gadus Morrhua, by the application of a temperature not exceeding 180° F., the solid fat having been separated by filtration at about 23° F.

Characters.—Pale yellow; odour slight, fishy, not rancid; taste bland, fishy. Sp. gr. ·920 to ·930. *Solubility.*—Readily in ether and chloroform, slightly in alcohol 90 per cent. A drop of H_2SO_4 added to a few drops of the oil on porcelain, develops a violet colour. *Impurities.*—Inferior oils.

Composition.—Cod-liver Oil consists chiefly of olein, margarin, palmitin and stearin (see *Adeps*, page 434), with about 5 per cent. of *free* fatty acids (oleic, palmitic, stearic); traces of iodine, bromine, trimethylamin, the ordinary inorganic salts of animal tissues and products; and several alkaloids. Some authorities give bile as a constituent; others deny this entirely, the biliary constituents being mainly insoluble in oil. *Dose*, 1 to 4 fl.dr.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

The actions and uses of oils *externally* have been discussed under the head of *Oleum Olivæ*, page 337. Cod-liver Oil is sometimes rubbed into the skin of wasting children as a nutritive, and with perfect success; but it imparts an objectionable colour and odour to the body.

Internally, with a little perseverance, it is as easily taken as other oils; and it is more easily digested, from the amount of free acid contained in it, which greatly facilitates saponification and emulsion as well as absorption.

2. ACTIONS ON THE BLOOD.

The fatty principles enter the circulation, carrying with them traces of the other constituents. Increasing the richness of the chyle, the Oil improves the quality of the blood, especially as regards the corpuscles, and is thus a hæmatinic.

3. SPECIFIC ACTIONS AND USES.

Passing into the cells, Cod-liver Oil is a **nutritive of the** first importance, whilst the traces of iodine, bromine, phosphates and other salts doubtless produce a slight specific action when the oil is given continuously for months. The latter effects are, however, quite secondary to those of the oil proper, that is to its effects as **a food.** Fats and fatty acids appear not only to be oxydised in the tissues, but to spare the metabolism of the nitrogenous elements. Cod-liver Oil differs from other oils (Olive and Almond Oils, cream, butter, etc.), chiefly, but not solely, in respect of the ease with which it is digested and absorbed.

Cod-liver Oil is very extensively used in almost all kinds of chronic disease attended with wasting. The chief of these diseases are scrofula in its various forms, phthisis, chronic bronchitis, rickets, tertiary syphilis, chronic rheumatism, and general debility referable to misery, over-work and under-feeding. In convalescence from acute illness it is of much service. It is also one of the best restoratives of the nervous functions, and of great value as a **nervine tonic** in neuralgia, headache, mental irritability, despondency, and other less definite disorders, referable to exhaustion or inherent debility of the nervous centres.

In every instance where Cod-liver Oil is indicated, the first point to be determined is whether it can be taken and digested. Besides the difficulty of taste, other conditions contra-indicate the exhibition of the Oil, particularly diarrhœa, hæmoptysis, and considerable fever. Gastric dyspepsia also suggests hesitation in the use of Oil; but if alkaline stomachics are given before meals, and the Oil after, it will be found to agree perfectly in most cases. If Oil be persistently rejected, it should be stopped for a time, and again cautiously tried, or given with Ether (10 minims of Purified Ether to 1 fl.dr. of Oil), with an aromatic oil, with Creosote, or as an emulsion.

Mel Depuratum.—CLARIFIED HONEY. Honey of commerce, melted in a water-bath and strained while hot through flannel previously moistened with warm water

Characters.—A viscid, translucent, light-yellowish or brownish liquid, gradually becoming partially crystalline and opaque. Odour characteristic; taste very sweet. *Impurities.*—Starch, etc.

Composition.—Honey is a complex mixture of several kinds of *sugar*, namely, cane sugar, grape sugar, and levulose

or inverted sugar (derived by fermentation from the cane sugar); wax, pollen, colouring and odorous matters, etc.

Preparation.

Oxymel.—8; Acetic Acid, 1; Water, about 1. Sp. gr. 1·320. *Dose*, 1 to 2 fl.dr.

Clarified Honey is also contained in Mel Boracis, Oxymel Scillæ, and Confectio Piperis.

ACTIONS AND USES.

Honey increases the secretions of the mouth and throat, and thus acts as a **demulcent**, relieving dryness, pain, cough and dysphagia. It is a popular ingredient of gargles, linctuses, and cough mixtures, but to be useful must be properly employed, as the Oxymel, or in combination with Lemon, which has a somewhat similar action on the mouth and pharynx. Honey is also **laxative and nutritive.**

Cera Flava.—YELLOW BEESWAX. *Source.*—Prepared from the honeycomb of the Hive Bee, Apis mellifica.

Characters.—Firm; yellowish; fracture granular; odour agreeable, honey-like. Not unctuous to the touch. Yields not more than 3 per cent. to cold alcohol 90 per cent., and not more than 50 per cent. to cold ether. *Solubility.*—Entirely soluble in hot oil of turpentine; insoluble in water and boiling solution of sodium hydroxide. Sp. gr. ·960 to ·970. Melts at 144·5° to 147° F. *Impurities.*—Starch; paraffins, melting under 146° F.; Japan wax; resin, soluble in cold alcohol; fatty acids, etc.

Composition.—Wax differs from ordinary fats in containing, as its base, not glyceryl, but another alcohol, *melissic alcohol*, $C_{30}H_{61}OH$, united with *cerotic acid*, $C_{26}H_{53}COOH$.

From Cera Flava is made:

Cera Alba.—White Beeswax. Yellow Beeswax which has been bleached by exposure to moisture, air and light. Hard, nearly white, translucent. *Impurities.*—As in Yellow Beeswax.

Preparations.

Yellow or White Beeswax is used in making many Plasters and Ointments and other preparations.

USE.

Wax is used only for pharmaceutical purposes. If given internally, it passes out in the fæces entirely unabsorbed.

Coccus.—COCHINEAL. The dried fecundated female insect, Coccus Cacti, reared on Nopalea coccinellifera, and on other species of Nopalea.

Characters.—About $\frac{1}{5}$ inch long; somewhat oval in outline, flat or concave beneath, convex above, transversely wrinkled; purplish-black or purplish-grey; easily reduced to powder, which is dark-red or puce-coloured. *Impurities.*—May be "faced" with various white or black powders to improve its appearance; these are detected by separation on maceration in water, and by excess of ash on incineration. *Resembles* Kino, which is astringent.

Composition.—Cochineal contains a red colouring principle, a glucoside, *carmine* or *carminic acid*, $C_{14}H_{14}O_8$, brownish-purple, amorphous, readily soluble in water and alcohol.

Preparation.

Tinctura Cocci.—1 in 10 of Alcohol 45 per cent.; by maceration. *Dose*, 5 to 15 min.

Coccus is also an ingredient of Tinctura Cardamomi Composita and Tinctura Cinchonæ Composita.

USE.

Cochineal is used as a colouring material only.

Cantharis.—CANTHARIDES. The dried Beetle, Cantharis vesicatoria.

Characters.—From $\frac{3}{4}$ to 1 inch long, $\frac{1}{4}$ inch broad; with two long elytra or wing-sheaths of a shining coppery-green colour, under which are two thin brownish membranous transparent wings. Odour strong, disagreeable. Powder greyish-brown, containing shining green particles.

Composition.—Cantharis contains ·4 to 1 per cent. of *cantharidin*, a greenish *volatile oil*, and peculiar *fatty bodies*. Cantharidin, $C_{10}H_{12}O_4$, probably an acid, is obtained as shining colourless plates; is volatile; is soluble in ether, acetic ether, glacial acetic acid, chloroform, alcohol and oils; and is the active principle, being a most powerful irritant. Some of the other properties of Cantharides may be referable to the oil.

Preparations.

1. **Acetum Cantharidis.**—Vinegar of Cantharides. 1; Glacial Acetic Acid, 5; Water, 5. By maceration and percolation.

2. **Emplastrum Cantharidis.** 7; Yellow Beeswax, 4; Soap Plaster, 1; Resin, 4; Lard, 4.

3. **Emplastrum Calefaciens.**—Warming Plaster. 4; Yellow Beeswax, 4; Resin, 4; Soap Plaster, 32; Resin Plaster, 52; boiling Water, 20.

4. **Liquor Epispasticus.**—Blistering Liquid. 10; Acetic Ether to make 20; by percolation.

From Blistering Liquid is prepared:

COLLODIUM VESICANS.—Blistering Collodion. Pyroxylin, 1; dissolved in Blistering Liquid, 40.

5. **Tinctura Cantharidis.**—1 in 80 of Alcohol 90 per cent.; by maceration. *Dose*, 5 to 15 min.; if frequently administered, 2 to 5 min.

6. **Unguentum Cantharidis.** 1; Benzoated Lard, 10.

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally.—Cantharis is a **rubefacient and vesicant** when applied to the skin, acting upon the nerves and vessels of the part like Mustard and other measures of the same class, as described under *Sinapis*, to which the reader is referred (page 243). Its effects differ from those of Mustard, chiefly in being much less rapid, but of a more severe degree. The Emplastrum or the Charta has to be applied for a few hours before a sense of smarting, heat and burning is felt in the part; small vesicles then form, and at the end of eight to twelve hours have united into a single large bulla. The removal of the Cantharides after six hours, and the application of a Boric Acid fomentation, will "raise the blister" more

effectually and pleasantly. Vesication is decidedly more rapid after the application of the Acetum, Liquor Epispasticus or Collodium Vesicans. When the blister has been developed, it is carefully incised, and the raw surface is then encouraged either to heal by simple dressing, or to discharge by the application of an irritant ointment. Cantharides is the vesicant in ordinary use for purposes of counter-irritation. Blisters are chiefly employed to control hyperæmia and the inflammatory process; to promote the absorption of morbid products; to relieve pain; and to arrest spasm and other reflex disturbances. The mode in which they are believed to act is discussed under *Counter-irritants* (page 608). Cantharides is most frequently used in cerebral hyperæmia, being applied to the nape; in acute pleurisy, pericarditis, peritonitis and meningitis—sometimes in the first stage, especially if pain be severe, but more frequently in the third stage, to promote absorption of effusions and exudations; in subacute or chronic inflammation of the viscera, such as pneumonia, when resolution is slow or the disease threatens to become chronic; and in subacute or chronic inflammation of peripheral parts, such as the conjunctiva, joints, bones, etc. Neuralgia, if distinctly local in origin and due to congestion or inflammation of the nerves, is sometimes completely relieved by Cantharides blisters; and the pains of acute rheumatism are undoubtedly dispelled by the same means, which are further believed by some physicians to cut short the whole rheumatic process. A blister on the epigastrium is a highly successful mode of treatment in some forms of gastric pain and vomiting.

In every instance Cantharides should be cautiously applied to children, to persons suffering from renal disease, and to the aged and infirm. The back must not be blistered in bed-ridden persons, lest bed-sores be produced. Blisters must never be forgotten nor left too long on the skin, otherwise ulceration may be set up, as well as the remote local effects of the drug to be presently described.

Internally.—Cantharides is an irritant to the mouth, throat and stomach, and must be given well diluted and in small doses of the Tincture only.

2. ACTIONS IN THE BLOOD AND SPECIFIC ACTIONS.

Cantharidin enters the blood both from blistered surfaces and from the stomach, and finds its way into all the organs, to which it clings rather tenaciously. In large doses it disturbs the heart, respiration and nervous system, producing a rapid pulse, headache, sensory disorders, mental confusion, and finally death by asphyxia. Repeated small doses may cause

disease of the capillaries, and set up changes in the solid viscera somewhat similar to those in chronic phosphorus poisoning.

3. REMOTE LOCAL ACTIONS AND USES.

Cantharidin is slowly excreted by the kidneys, appearing in the urine, which conveys it to the bladder and genital organs. Here it sets up a second set of local effects, similar to those of its immediate action. Small doses cause a sense of heat in the perinæum, itching of the meatus, frequent desire to micturate, and some **diuresis.** Larger doses set up acute general parenchymatous nephritis, with all its characteristic symptoms, including scanty bloody urine, or even suppression; the penis becomes swollen; and painful erections occur, so that the drug has been described as an aphrodisiac. In women, the uterus may become congested and menstruation brought on.

In certain cases of renal disease Cantharides proves a useful diuretic, and it is given in some genito-urinary disorders, including spermatorrhœa; but it is too dangerous to be generally used internally. For this reason care must be taken to prevent the absorption of cantharidin by the skin.

Hirudo. — LEECHES. Sanguisuga medicinalis, the Speckled Leech; and Sanguisuga officinalis, the Green Leech.

Characters.—Body soft, smooth, 2 inches or more long, tapering to each end, plano-convex, marked with 90 to 100 fine annulations, back olive-green; both varieties have six rusty-red longitudinal stripes. (1) Belly greenish-yellow, spotted with black; (2) belly olive-green, not spotted. The anterior end is terminated by a small sucker surrounding the tri-radiate jaws; and the posterior end by a large sucker.

ACTIONS AND USES.

The Leech is employed to **abstract blood,** each Leech removing, directly and by subsequent hæmorrhage, an average of half an ounce of blood. The effect of leeching is depletive; to some extent counter-irritant. It is employed in congestive or inflammatory affections, superficial and visceral, as well as in cardiac distension and distress. (*See* page 550.)

Part III.

THE INDIAN AND COLONIAL ADDENDUM TO THE BRITISH PHARMACOPŒIA.

Acaciæ Cortex.—ACACIA BARK, BABUL BARK. (India, Eastern and Australian Colonies.) The dried bark of Acacia arabica and Acacia decurrens. N O. Leguminosæ. Black Wattle Bark.

Characters.—Hard, brown; inner surface red; taste astringent.

Composition.—The bark is rich in *tannic acid*—20 per cent.

Preparation.

Decoctum Acaciæ Corticis.—1¼ oz. in 20 fl. oz. Water; boiled for 10 minutes. *Dose*, ½ to 2 fl. oz.

ACTIONS AND USES.

Astringent as an injection; used in diarrhœa.

Acalypha.—ACALYPHA. (India, and Eastern Colonies.) The fresh and dried herb of Acalypha indica. N.O. Euphorbiaceæ.

Characters.—Stem erect, 1 to 2 feet high; leaves ovate-cordate, serrated; spikes, axillary; male flowers uppermost, enclosed in a funnel-shaped involucre; stamens, 8 to 16; styles, 3; capsules tricoccous, three-celled, one-seeded. Flowers small, green.

Composition.—Contains a *resin*, *tannin*, and an alkaloid, *acalyphine*.

Preparations.

1. **Extractum Acalyphæ Liquidum.**—Dried Herb, 1; Alcohol 90 per cent., 20; by percolation. *Dose*, 5 to 30 min.
2. **Succus Acalyphæ.**—Expressed juice, 3; Alcohol 90 per cent., 1. *Dose*, 1 to 4 fl. dr.

ACTIONS AND USES.

Resembles Ipecacuanha as an emetic, sedative expectorant and laxative, *see* page 318. Introduced into the rectum as a thick paste, it unloads the bowel.

Adhatoda.—ADHATODA. (India, and Eastern Colonies.) The fresh and dried leaves of Adhatoda Vasica. N.O. Acanthaceæ.

Characters.—Fresh leaves 5 to 6 in. long, 1½ in. broad, lanceolate, entire, tips pointed, smooth. Dried leaves dark green; odour tea-like; taste bitter.

Composition.—Contains (1) *vasicine*, a bitter crystalline alkaloid; (2) *adhatodic acid;* and (3) an odorous volatile principle.

Preparations.

1. **Extractum Adhatodæ Liquidum.**—Equal parts of dried and powdered leaves; Alcohol 60 per cent., to make 20 oz. by percolation. *Dose*, 20 to 60 min.
2. **Succus Adhatodæ.**—Fresh juice, strained. *Dose*, 1 to 4 fl. dr.
3. **Tinctura Adhatodæ.**—Dried and powdered leaves, 125; Alcohol 60 per cent., 1,000. *Dose*, 30 to 60 min.

ACTIONS AND USES.

A stimulant expectorant and antispasmodic, like Senega (page 245). It is also a valuable insecticide for blight on tea and other crops.

Agropyrum. — TRITICUM. "COUCH GRASS. (India, Australasia and Eastern Colonies.) The dried rhizome of Agropyrum repens (Triticum repens). N.O. Graminaceæ.

Characters.—Pale yellow, $\frac{1}{12}$ to $\frac{1}{10}$ in. in diameter; usually in sections $\frac{1}{8}$ to $\frac{1}{4}$ in. long; furrowed longitudinally; no odour; taste sweetish.

Composition.—Contains *triticin* (7 to 8 per cent.), and *saccharine* and *gummy substances.*

Preparations.

1. **Decoctum Agropyri.**—1 in 20. *Dose*, ½ to 2 fl. oz.
2. **Extractum Agropyri Liquidum.**—20 oz.; Alcohol 90 per cent., 5 oz.; Water, q.s. by digestion and evaporation to 20 oz. *Dose*, 1 to 2 fl. dr.

ACTIONS AND USES.

The rhizome, fresh and dried, is used as a diuretic and sedative in cystitis and irritation of the urinary passages.

Alstonia.—Alstonia. (India, Australasia and Eastern Colonies.) The dried bark from Alstonia scholaris and Alstonia constricta. "Dita Bark" of the Philippine Islands. N.O. Apocynaceæ.

Characters.—The bark of *Alstonia scholaris.* In fragments ⅛ to ½ inch thick, spongy, brownish-grey outside, bright buff within; no odour; taste, bitter.—The bark of *Alstonia constricta.* In curved pieces or quills 2½ in. wide, ½ in. thick. Periderm thick, rusty-brown, rugose, reticulated. Internally, cinnamon-brown, with longitudinal striæ; odour faint, aromatic; taste very bitter.

Composition.—Contains many alkaloids, especially *ditaine* (from *A. scholaris*) and *alstonine* (from *A. constricta*).

Preparations.

1. **Infusum Alstoniæ.**—1 in 20. *Dose*, ½ to 1 fl. oz.
2. **Tinctura Alstoniæ.**—Powdered Bark, 125; Alcohol 60 per cent., 1,000. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Astringent, anti-periodic, tonic and anthelmintic. Very useful in chronic diarrhœa, dysentery and malarial fevers. Ditaine paralyses motor nerve-endings.

Andrographis.—Andrographis. Creyat, Kiryat, or Kreat. (India and Eastern Colonies.) The dried plant of Andrographis paniculata. N.O. Acanthaceæ.

Characters.—Stem, 1 to 3 feet high, quadrangular, slightly winged, furrowed longitudinally; colour, dark green. Leaves opposite, shortly petiolate, lanceolate, entire; upper surface dark green, shining; lower surface granular; variable in size. Flowers: calyx small, hairy, five-cleft; capsules cylindrical, two-valved. Root simple, fusiform, woody. No odour in *dried* plant; taste intensely bitter.

Composition.—Contains a *non-basic bitter principle.*

Preparations.

1. **Infusum Andrographidis.**—1 in 20. *Dose*, ½ to 1 fl. oz.
2. **Liquor Andrographidis Concentratus.**—10; Alcohol 20 per cent., 25; percolate to 20. *Dose*, ½ to 1 fl. dr.
3. **Tinctura Andrographidis.**—1 in 10 of Alcohol 60 per cent.; by percolation. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

A bitter stomachic, tonic and anthelmintic, resembling Quassia (page 264).

Aristolochia.—Aristolochia. (India and Eastern Colonies.) The dried stem and root of Aristolochia indica. N.O. Aristolochiaceæ.

Characters.—Stem in cylindrical pieces, § in. in diameter; greyish-yellow, marked with scars and furrows. Root dark brown, transversely constricted; bark separable from wood. Odour spicy, camphoraceous; taste bitter and camphoraceous.

Composition.—Contains *aristolochine*, a bitter alkaloidal principle, and a *volatile oil* (which contains borneol) to which is due the odour and taste of the drug. (*See* Serpentariæ Rhizoma, page 379.)

Preparations.

1. **Liquor Aristolochiæ Concentratus.**—500; Alcohol 20 per cent., 1,250. *Dose*, ½ to 2 fl. dr.
2. **Tinctura Aristolochiæ.**—1; Alcohol 70 per cent., 5; by percolation. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

A mild bitter tonic, resembling Serpentary (page 379).

Arnicæ Flores.—Arnica Flowers. (North American Colonies.) The dried flower-heads of Arnica montana. N.O. Compositæ.

Characters.—Consist of a scaly involucre in two rows, and a hairy receptacle bearing 16 to 20 yellow, three-toothed, ten-nerved ray-florets, and numerous yellow, five-toothed tubular disk-florets. Odour aromatic; taste bitter and acrid.

Composition.—Contain a *volatile oil*, *resin*, and a crystalline bitter, *arnisterin* (arnicin); *see* page 329.

Preparation.

Tinctura Arnicæ Florum.—1 in 10 of Alcohol 40 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

See Arnica, page 329.

Aurantii Cortex Indicus.—Indian Orange Peel. (India and the Colonies, in place of other *Orange Peel.*) The fresh and dried outer part of the

pericarp of varieties of Citrus Aurantium. N.O. Rutaceæ.

Characters and *Composition.*—*See* page 253.

ACTIONS AND USES.

Used as a vehicle for lotions, as a bitter stomachic and tonic, and as a flavouring agent. (*See* Bitters, pages 220, 342, 473.)

Azadirachta Indica. — Indian Azadirach. "Neem or Margosa Bark." (India, and Eastern Colonies.) The dried bark of the stem of Melia azadirachta. N.O. Meliaceæ.

Characters.—Externally rusty-grey; internally yellowish, fibrous; taste bitter; inodorous.

Composition.—Contains a *resin* and a bitter crystalline alkaloid *margosine*.

Preparations.

1. **Infusum Azadirachtæ Indicæ.**—1 in 100. *Dose*, ½ to 1 fl. oz.
2. **Tinctura Azadirachtæ Indicæ.**—1 in 10 of Alcohol 45 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Allied to Calumba and similar bitters; and used in scaly skin affections. The root-bark is anthelmintic.

Belæ Fructus.—Bael Fruit. (India, and Eastern Colonies.) The fresh *half-ripe* fruit of Ægle Marmelos. N.O. Rutaceæ.

Characters.—Three in. in diameter, ovoid or pyriform, smooth; ten to fifteen cells, containing yellow seeds; pulp, juicy, hard and brittle on drying; taste mucilaginous, acid, astringent.

Composition.—Contains *pectin*, *mucilaginous* principles, and a small amount of *tannin*.

Preparation.

Extractum Belæ Liquidum.—1 in 1 of Alcohol, 90 per cent. by maceration and evaporation. *Dose*, ½ to 2 fl. dr.

ACTIONS AND USES.

The *unripe* fruit is astringent, and is used in dysentery.

Berberis.—BERBERIS. "DARLAHAD." (India, and Eastern Colonies.) The dried stem of Berberis aristata. N.O. Berberidaceæ.

Characters.—Undulating pieces, 1 to 2 in. thick, covered with orange-brown periderm, bright yellow; odour faint; taste bitter.

Composition.—Contains two alkaloids, *oxycanthine* and *berberine* (page 219).

Preparations.

1. **Liquor Berberidis Concentratus.**—1 in $2\frac{1}{2}$ of Alcohol 20 per cent. *Dose*, $\frac{1}{2}$ to 1 fl. dr.
2. **Tinctura Berberidis.**—1 in 10 of Alcohol 60 per cent. *Dose*, $\frac{1}{2}$ to 1 fl. dr.

ACTIONS AND USES.

A mild astringent, bitter tonic and stomachic; diaphoretic, antipyretic and antiperiodic, allied but inferior to Quinine

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Betel.—BETEL. (India, and Eastern Colonies.) The leaves of Piper Betle. "Pan." N.O. Piperaceæ.

Characters.—Broadly ovate, acuminate, obliquely cordate at base, glossy upper surface; taste, warm, aromatic, bitter.

Composition.—Contain (1) two aromatic oils, light and heavy, which yield *chavibetol*—an isomer of eugenol (a powerful antiseptic)—when treated with caustic potash. (2) An alkaloid, *arakene*, allied to cocaine in action. The characteristic odour of oil and leaves is due to "*betel-phenol.*"

ACTIONS AND USES.

A mild, aromatic sialogogue, allaying thirst, stomachic and carminative. The alkaloid arakene probably is the active agent in allaying hunger when pan is chewed. Betel is a good vehicle for counteracting the after-taste of nauseous and bitter drugs.

Buteæ Gummi. — BUTEA GUM. BENGAL KINO. (India, and Eastern Colonies.) The inspissated juice obtained from incisions in the stem of Butea frondosa. N.O. Leguminosæ.

Characters.—Small, irregular, shining fragments, dark ruby colour; inodorous; taste astringent. *Solubility:* Partially in water. *Impurities:* Woody and corky particles.

Composition.—*See* Kino, page 271.

ACTIONS AND USES.

Bengal Kino is used for the same purposes as the more familiar drug. *See* Kino, page 271.

Buteæ Semina.—Butea Seeds. (India, and Eastern Colonies.) The seeds of Butea frondosa. N.O. Leguminosæ.

Characters.—Flat, reniform, 1 to 1½ in. long, ¾ to 1 in. wide, $\frac{1}{12}$ in. thick; testa, thin, glossy, wrinkled, reddish-brown; hilum, large, prominent. Odour faint; taste slightly acrid.

Composition.—Contain fat, albuminoids, and *metarabic acid*. No alkaloid has been found in the seeds.

Preparation.

Pulvis Buteæ Seminum.—*Dose*, 10 to 20 gr.

ACTIONS AND USES.

Used as a rubefacient externally in ringworm. Internally, the seeds are a powerful anthelmintic for round-worm. (*See* Santonin, page 326.)

Calotropis. — Calotropis. Mudar. (India, and Eastern Colonies.) The dried root bark of Calotropis procera and of Calotropis gigantea, freed from outer corky layer. Gathered in April and May. N.O. Asclepiadaceæ.

Characters.—In short quilled pieces $\frac{1}{10}$ to ⅛ in. thick, 1½ in. wide, with soft, greyish, strongly furrowed periderm. This layer should be removed before powdering; odour faint; taste mucilaginous, bitter, acrid.

Composition. — Contains *madaralban* and *madarfluavil* (analogous to the resinous constituents of Guttapercha) and Caoutchouc. *Dose*, 3 to 10 gr. as a tonic; 30 to 60 gr. as an emetic.

Preparation.

Tinctura Calotropis.—1 in 10 of Alcohol 60 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Calotropis is anodyne, rubefacient, expectorant, and emetic; allied to Ipecacuanha (page 319). It is used in dysentery.

Cambogia Indica.—INDIAN GAMBOGE. (India, and Eastern Colonies.) The gum-resin obtained from Garcinia Morella. N.O. Guttiferæ.

Characters.—Must have all the important characters and respond to the tests of the B.P. Gamboge (page 261). *Impurities:* Leaves and similar extraneous matters and particles of wood.

Composition.—*See* Cambogia, page 261. *Dose*, ½ to 2 gr.

ACTIONS AND USES.

The same as ordinary Siam Gamboge (page 261)

Catechu Nigrum.—BLACK CATECHU. (India, Eastern Colonies, and North American Colonies.) An extract prepared from the wood of Acacia Catechu. N.O. Leguminosæ.

Characters.—Irregular masses of a dark-brown colour; inodorous; taste sweet, astringent. *Solubility:* Partially in cold, freely in boiling, water.

Composition.—Contains *catechu-tannic acid.* It does not contain a fluorescent constituent as found in Pale Catechu (*see* page 321). *Dose*, 5 to 15 gr.

ACTIONS AND USES.

A non-irritating astringent, like Tannic Acid (page 393). (*See also* Catechu, page 321.) Used in dentifrices, gargles and lozenges for sponginess of the gums. Is a constituent of prepared Pan, which is freely chewed by the natives of India.

Cissampelos.—CISSAMPELOS. FALSE PAREIRA BRAVA. (India, and Eastern Colonies.) The dried root bark of Cissampelos Pareira. N.O. Menispermaceæ.

Characters.—Compressed, undulating pieces, ½ in. in diameter, covered with dark brown bark, with longitudinal furrows and transverse cracks; no odour; taste very bitter.

Composition.—Contains an alkaloid, *pelosine.* (*See* page 222.)

Preparations.

1. **Decoctum Cissampeli.**—2½ oz.; Water, q.s. to make 20 oz. *Dose*, ½ to 2 fl. oz.
2. **Extractum Cissampeli Liquidum.**—1 in 1. *Dose*, ½ to 2 fl. dr.

ACTIONS AND USES.

Similar to those of true Pareira Root (page 221). *See* Agropyrum (page 444).

Coscinium.—COSCINIUM. "FALSE CALUMBA." (India, and Eastern Colonies.) The dried stem of Coscinium fenestratum. N.O. Menispermaceæ.

Characters.—In woody cylindrical, straight or twisted pieces, about 4 in. in diameter; furrowed longitudinally; with a pale yellowish-grey cork; no odour; taste bitter.

Composition.—Contains *berberine* (*see* page 219) and *coscinium-saponin.*

Preparations.

1. **Infusum Coscinii.**—1 in 20. *Dose*, ½ to 1 fl. oz.
2. **Liquor Coscinii Concentratus.**—1 in 2 of Alcohol 90 per cent.; Water q.s. *Dose*, ½ to 1 fl. dr.
3. **Tinctura Coscinii.**—1 in 10 of Alcohol 60 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Exactly like those of Calumba (page 219).

Cucurbitæ Semina Præparata.—MELON PUMPKIN SEEDS. REDGOURD SEEDS. (Mediterranean Colonies.) The prepared fresh ripe seeds of cultivated plants of Cucurbita maxima (Cucurbita Pepo). N.O. Cucurbitaceæ.

Characters.—Flat, ovate, white, exalbuminous, consisting of two cotyledons deprived of testa and tegmen; odour faint; taste very slight. Seeds must not be more than one month old.

Composition.—Contains an acrid *resin* and a *fixed oil.* *Dose*, 3 to 4 oz.

ACTIONS AND USES.

An efficient anthelmintic for tapeworm. Bruised with a little water or milk to a creamy consistence, it is given, fasting, early in the morning, followed by a purgative.

Daturæ Folia.—DATURA LEAVES. (India, and Eastern and West Indian Colonies.) The dried leaves of Datura fastuosa and of Datura Metel. N.O. Solanaceæ.

Characters.—Ovate, acuminate, with long petioles and

sinuate-dentate margins, 7 to 8 in. long, 4 to 5 in. broad; odour characteristic; taste bitter.

Composition.—*See* Stramonii Folia (page 360).

ACTIONS AND USES.

The same as those of Stramonium Leaves (page 360).

Daturæ Semina.—DATURA SEEDS. (India, and Eastern Colonies.) The dried seeds of Datura fastuosa. N.O. Solanaceæ.

Characters.—Wedge-shaped; rounded, furrowed, thickened, wavy margins, compressed laterally; $\frac{1}{6}$ to $\frac{1}{5}$ in. broad; $\frac{1}{25}$ in. thick. Hilum on one edge. Testa finely pitted, reticulated. Taste bitter.

Composition.—*See* Stramonii Semina (page 360).

Preparation.

Tinctura Daturæ Seminum.—1 in 4 of Alcohol 70 per cent. *Dose*, 5 to 15 min.

ACTIONS AND USES.

The same as those of Stramonium Seeds (page 360).

Embelia. — EMBELIA. (India, and Eastern Colonies.) The fruit of Embelia Ribes and of Embelia robusta. N.O. Myrsinaceæ.

Characters.—Globular, $\frac{1}{6}$ in. in diameter, dull red with dark spots to nearly black, containing a horny reddish seed. Taste slightly astringent, aromatic.

Composition.—Contains *embelic acid*. *Dose*, 1 to 4 dr.

ACTIONS AND USES.

A valuable anthelmintic for tapeworm, used like Melon Pumpkin seeds (page 451) or Cusso (page 288). The ammonium salt of embelic acid is tasteless, and is a useful and effective anthelmintic for children.

Glycyrrhizæ Extractum Spirituosum.—(India, and Eastern Colonies.) Extract of Liquorice, 2; Alcohol 90 per cent., 1; Water, 5. *Dose*, ½ to 1 dr.

ACTIONS AND USES.

An excellent demulcent and flavouring agent (page 269).

Gossypii Radicis Cortex. — Cotton Root Bark. (India, Eastern, North American and West Indian Colonies.) The dried root bark of Gossypium herbaceum. N.O. Malvaceæ.

Characters.—In thin flexible bands or quilled pieces, covered with a thin brownish-yellow periderm; inodorous; taste, slightly acrid, astringent.

Composition. — Contains a lemon-yellow or colourless chromogen, an acid *resin*, a *fixed oil*, *starch*, and traces of *tannin*.

Preparations.

1. **Decoctum Gossypii Radicis Corticis.**—1 in 5 in Water. *Dose*, ½ to 2 fl. oz.
2. **Extractum Gossypii Radicis Corticis Liquidum.**—1 in 1. Bark, 20 oz.; Glycerin, 5 oz.; Alcohol 90 per cent. q.s. to percolate 20 oz. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Employed as a substitute for Ergot (page 422).

Grindelia. — Grindelia. (Australasian and North American Colonies.) The dried leaves and flowering tops of Grindelia squarrosa and of Grindelia robusta. N.O. Compositæ.

Characters.—*Leaves* of Grindelia squarrosa alternate, pale green, smooth, coriaceous, brittle, oblanceolate; and at the sessile base the involucral bracts long, with reflexed subulate points. *Leaves* of Grindelia robusta almost similar, but shorter, with a cordate amplexicaul base and a serrated margin. Odour balsamic; taste pungent, bitter, aromatic.

Composition.—Contain a resin allied to *saponin* (*see* page 245), a volatile oil, and a doubtful alkaloid.

Preparation.

Extractum Grindeliæ Liquidum.—1 in 1, by percolation with Alcohol 90 per cent., Water and Sodium Bicarbonate. *Dose*, 10 to 20 min. (Spiritus Chloroformi conceals its bitter taste.)

ACTIONS AND USES.

Grindelia is a mild stomachic, an expectorant and bronchial antispasmodic. It is much used in asthma and other spasmodic respiratory affections. The dermatitis caused by Rhus toxicodendron ("Poisonous Ivy") is relieved by the

application of the diluted extract (1 to 48). It also makes a useful dressing for ulcers and burns.

Gummi Indicum.—INDIAN GUM. GHATI or GHATTI GUM. (India, and Eastern Colonies.) A gummy exudation from the wood of Anogeissus latifolia. N.O. Combretaceæ.

Characters.—Amber-coloured, translucent, vermiform or rounded tears, with a dull surface and glassy fracture; odour faint; taste mucilaginous. Forms a mucilage with water.

Composition.—Contains *arabic acid;* its calcium salt is arabin.

Preparation.

Mucilago Gummi Indici.—1 in 3 of Water.

ACTIONS AND USES.

The same as those of Gum Acacia (page 283)

Hirudo Australis.—AUSTRALIAN LEECH. (Australasian Colonies.) Hirudo quinquestriata. Order Hirudinea. *See* Hirudo, page 442.

Characters.—Dorsal surface greenish-yellow-brown, with five longitudinal stripes; ventral surface greenish-yellow, not spotted.

ACTIONS AND USES.

See page 442.

Hygrophila. — HYGROPHILA. ASTERACANTHA. (India, and Eastern Colonies.) The dried herb, including the root, of Hygrophila spinosa. N.O. Acanthaceæ.

Characters.—Roots with numerous rootlets, tapering; stem 2 to 4 feet high, quadrangular; branches and leaves opposite, leaves entire, 6 at each node; outer 2, about 4 to 5 in. long and $\frac{1}{2}$ in. broad; 4 inner, about $1\frac{1}{2}$ in. long. In axii of each leaf is a yellowish spine about 1 in. long. Leaves and stem furnished with hispid, spreading, scattered white hairs. Flowers bright purplish-blue, 4 pairs at each node. Calyx, 4 sepals, one broader than the others. Corolla glabrous, two-lipped, with didynamous stamens. Ripened ovary with 4—8 seeds.

Composition.—Contains an *alkaloidal* matter, a *fixed oil, inorganic salts* and *mucilage*, and *phytosterin.*

Preparation.

Decoctum Hygrophilæ.—1 in 10. *Dose*, ½ to 2 fl. oz.

ACTIONS AND USES.

A diuretic, and sedative to the genito-urinary tract. *See* Agropyrum (page 444).

Ispaghula.—Spongel Seeds. (India, and Eastern Colonies.) The dried seeds of Plantago ovata N.O. Plantaginaceæ.

Characters.—About $\frac{1}{10}$ in. long and $\frac{1}{20}$ in. wide; ovate, elliptical, boat-shaped, pinkish; convex side bearing a dark spot; inodorous and tasteless.

Composition.—Contains *mucilage, fixed oil,* and *albuminous* matter. *Dose,* 50 to 150 gr.

Preparation.

Decoctum Ispaghulæ.—13·7; Water, 1,000. *Dose,* ½ to 2 fl. oz.

ACTIONS AND USES.

Allied to Linum (page 251), it is used in dysentery and diarrhœa, and as a demulcent in cough and pharyngeal disorders, particularly for children.

Kaladana. — Kaladana. Pharbitis Nil. (India, and Eastern Colonies.) The dried seeds of Ipomœa hederacea. N.O. Convolvulaceæ.

Characters.—$\frac{3}{16}$ in. long and wide, in segments of spheres; black throughout, brown and hairy only at the hilum; odour earthy; taste acrid.

Composition.—Contains about 8 per cent. of a resin consisting entirely of *pharbitisin*—a glucoside resembling *jalapin* in its chemical properties. *Dose,* 30 to 50 gr. in powder.

Preparations.

1. **Pulvis Kaladanæ Compositus.**—5; Acid Potassium Tartrate, 9; Ginger, 1. *Dose,* 20 to 60 gr.
2. **Tinctura Kaladanæ.**—1 in 5 of Alcohol 70 per cent. *Dose,* ½ to 1 fl. dr.

ACTIONS AND USES.

The same as those of Convolvulin of Jalap (page 350).

Kaladanæ Resina. — Kaladana Resin. Pharbitisin. (India, and Eastern Colonies.) A resin obtained from Kaladana Seeds.

Characters.—In brownish opaque fragments, translucent at the edges; brittle, breaking with a resinous fracture; odour disagreeable, especially when warmed; taste sweetish, acrid to the throat. Readily soluble in Alcohol 90 per cent. *Dose*, 2 to 8 gr.

ACTIONS AND USES.

These are the same as those of Jalap Resin (page 350).

Kavæ Rhizoma.—Kava Rhizome. Kava-Kava. (Australasian Colonies.) The dried decorticated rhizome, without roots, of Piper methysticum. N.O. Piperaceæ.

Characters.—Irregular fragments ½ to 2 in. thick, of a pale greyish colour; odour somewhat pleasant; taste piperaceous, slightly bitter, and saponaceous.

Composition.—Contains *kavalin* or *methysticin*, allied to *piperin*, and *karvin*, an acrid resin. *Dose*, 5 to 10 gr.

Preparation.

Extractum Kavæ Liquidum.—1 in 1 of Alcohol 90 per cent. and 45 per cent. *Dose*, 30 to 60 min.

ACTIONS AND USES.

A bitter tonic. Karvin produces local anæsthesia, like Cocaine, but the pain produced forbids its use as such (*see* Cocaine, page 248). It is also used as a diuretic, and in gonorrhœa and other affections of the genito-urinary tract.

Kino Eucalypti.—Eucalyptus Kino. Botany Bay Kino. (Australasian Colonies.) An exudation from the stems of various species of Eucalyptus, N.O. Myrtaceæ, having the *characters* and answering to the *tests* for Kino.

Characters.—Similar to East India Kino (page 271), to the tests for which it responds.

Composition.—Contains kino-tannic acid, catechin, pyrocatechin, resin and gum. *Dose*, 5 to 20 gr. in powder.

ACTIONS AND USES.

A powerful intestinal astringent, allied to Krameria, Catechu, and Tannin (pages 246, 321, 393).

Mylabris.—Mylabris. The Telini Fly. (India, Eastern and African Colonies.) The dried beetle Mylabris phalerata. Order Coleoptera.

Characters.—About 1 in. long, $\frac{3}{8}$ in. wide. Two elytra long, black, with two broad wavy, orange-coloured transverse bands, and a large orange-coloured spot at the base. A pair of brown membranous wings. Odour disagreeable.

Composition.—Contains 1 to 2 per cent. of *cantharidin* (page 440).

Preparations.

1. **Acetum Mylabridis.**—1, Glacial Acetic Acid, 5; Water, 5.
2. **Emplastrum Mylabridis.**—35; Yellow Bees-wax, 20; Lard, 20; Resin, 20; Soap Plaster, 5.
3. **Emplastrum Califaciens Mylabridis.**—1; Yellow Bees-wax, 1; Resin, 1; Resin Plaster, 13; Soap Plaster, 8; Boiling Water, 5.
4. **Liquor Epispasticus Mylabridis.**—1 in 2 of Acetic Ether.
5. **Unguentum Mylabridis.**—1 in 10 of Benzoated Lard.

ACTIONS AND USES.

Similar to those of Cantharides (page 440).

Myrobalanum.—Myrobalans. Black or Chebulic Myrobalans. (India, and Eastern Colonies.) The dried immature fruits of Terminalia Chebula. N.O. Combretaceæ.

Characters.—About $\frac{1}{3}$ to $\frac{3}{4}$ in. long, $\frac{3}{8}$ in. wide, ovoid or fusiform like an olive, but shrivelled longitudinally; black, solid and brittle; fracture shining; taste very astringent.

Composition.—Contains about 25 per cent. of *gallo-tannic acid*, a *resin*, and a bitter principle.

Preparations.

1. **Unguentum Myrobalani.**—1 in 4 of Benzoated Lard.
2. **Unguentum Myrobalani cum Opio.**—Myrobalan Ointment, 925; Powdered Opium, 75.

ACTIONS AND USES.

Astringent and tonic, allied to Acidum Tannicum (page 393).

Oleum Ajowan.—Ajowan Oil. Ptychotis Oil. (India, and Eastern Colonies.) The oil distilled

from the fruit of Carum copticum. N.O. Umbelliferæ.

Characters.—Colourless, with the odour and taste of thyme. Sp. gr. ·917 to ·930.

Composition.—Yields 30 to 36 per cent. of crystalline *thymol* if cooled to 32° F.; also contains *thymene*, a mixture of a terpene and cymene. *Dose*, ½ to 3 min.

ACTIONS AND USES.

Allied to Thymol (page 371). It is an excellent carminative and antispasmodic.

Oleum Arachis.—ARACHIS OIL. EARTH-NUT, GROUND-NUT, or PEA-NUT OIL. (Africa, and Eastern Colonies.) Expressed without heat from the seeds of *Arachis hypogæa.* N.O. Leguminosæ.

Characters.—Pale yellow or greenish-yellow; odour faint, nutlike; taste, bland nutty; slowly becomes rancid and thick. Sp. gr. ·916 to ·918.

Composition.—Contains *oleic, palmitic, arachic,* and *hypogœic acids.*

ACTIONS AND USES.

A very good substitute for almond and olive oils (pages 285 and 336).

Oleum Gaultheriæ.—OIL OF GAULTHERIA. OIL OF WINTERGREEN. (North American Colonies.) The oil distilled from the leaves of Gaultheria procumbens, N.O. Ericaceæ, or from the bark of the sweet birch, Betula lenta, N.O. Betulaceæ.

Characters.—Colourless or slightly yellowish; odour strong, characteristic; taste warm, sweetish, aromatic; sp. gr. 1·176 to 1·187.

Composition.—Contains 90 per cent. of natural *salicylate of methyl* and small quantities of a paraffin—*triacontane. Dose*, 3 to 10 min.

ACTIONS AND USES.

Closely allied in action to Salicylates (pages 387-391); and in America is frequently used in acute rheumatism.

Oleum Graminis Citrati.—OIL OF LEMON GRASS. INDIAN OIL OF VERBENA. (India, Eastern

and West Indian Colonies.) The oil distilled from Andropogon citratus (Andropogon schœnanthus). N.O. Graminaceæ.

Characters.—A dark yellow oil, resembling Oil of Verbena in odour. Sp. gr. 0·895 to 0·905.

Composition.—Contains an aldehyde, *citral*, and *citronellal*. *Dose*, ½ to 3 min.

ACTIONS AND USES.

Oil of Lemon Grass resembles Oil of Cajuput (page 294), and is used as a carminative, rubefacient, and stimulant.

Oleum Gynocardiæ. — Gynocardia Oil. Chaulmoogra Oil. (India, and Eastern Colonies.) The fatty oil expressed from the seeds of N.O. Bixaceæ, Gynocardia odorata or of Gynocardia Prainii.

Characters. — Brownish-yellow, of varying consistence; odour characteristic; taste acrid. Liquefies fully at 107·6° F. resolidifying at different temperatures below 60° F. *Solubility:* Partly in Alcohol 90 per cent.; freely in ether, chloroform, and carbon bisulphide. The oil expressed from the seeds of Hydrocarpus wightiana is sometimes substituted for Oleum Gynocardiæ.

Composition.—Contains *gynocardic acid* (12 to 20 per cent.). This acid can be obtained in crystals, and possesses a burning, acrid taste. *Dose*, 5 to 10, 30 or 60 min. in capsules, after food. Administration should be suspended if the stomach become irritant.

Preparation.

Unguentum Gynocardiæ.—1; Hard Paraffin, 4; Soft Paraffin, White, 5.

ACTIONS AND USES.

A powerful rubefacient. It is extensively used in leprosy, lupus, eczema, and psoriasis. (*See also* page 297.)

Oleum Sesami. — Sesame Oil. (India and African, Eastern and North American Colonies.) The oil expressed from the seeds of Sesamum indicum. N.O. Pedaliaceæ.

Characters.—Pale yellow, limpid; odour, faint; taste bland. Sp. gr. ·921 to ·924.

Composition.—Contains about 75 per cent. of a crystalline substance *sesamin*, and a phenol compound *sesamol*.

ACTIONS AND USES.

Used as a substitute for Olive Oil to make ointments, plasters and liniments.

Oliveri Cortex.—Oliver Bark. Oliver or Black Sassafras Bark. (Australasian Colonies.) The dried bark of Cinnamomum Oliveri. N.O. Lauraceæ.

Characters.—About 8 in. long, 1½ in. wide, flat, covered with granular periderm of a deep orange-brown colour; the tissue beneath and the bark inside umber-brown; odour aromatic, spicy; taste agreeable, spicy, camphoraceous.

Composition.—Contains a golden-yellow *volatile oil* (1 per cent.) and *tannin*.

Preparation.

Tinctura Oliveri Corticis.—1 in 10 of Alcohol 60 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

The same as Cinnamon and Sassafras (pages 375, 379).

Picrorhiza. — Picrorhiza. Kutki, Katki. (India, and Eastern Colonies.) The dried rhizome of Picrorhiza Kurroa. N.O. Scrophulariaceæ.

Characters.—Short pieces about ¼ in. diameter, as thick as a goose quill, tapering downwards, beset with prominent scars and remains of the rootlets; the large upper part beset with dark greyish-brown scales; inodorous; taste very bitter.

Composition.—Contains a bitter glucoside, *picrorhizin*, *gum*, and *cathartic acid*. *Dose*, 10 to 20 gr. as a tonic; 40 to 50 gr. as an antiperiodic.

Preparations.

1. **Extractum Picrorhizæ Liquidum.**—1 in 1 of Alcohol 60 per cent. *Dose*, 20 to 60 min.
2. **Tinctura Picrorhizæ.**—1 in 8 (by maceration) of Alcohol 45 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

A bitter acid stomachic and mild cathartic. Used in dyspepsia and gastric neuroses.

Podophylli Indici Rhizoma.—Indian Podophyllum Rhizome. (India, and Eastern Colonies.)

The dried rhizome and roots of Podophyllum Emodi. N.O. Berberadaceæ.

Characters.—Horizontal, more or less cylindrical and contorted, ¼ in. to ⅓ in. thick, crowded above with tuberosities, marked by depressed scars; giving off numerous simple rootlets from under surface; earthy brown; odour faint; taste bitter, acrid.

Composition.—Contains double the amount of *resin* yielded by Podophylli Rhizoma (page 218); but the resin contains only half the quantity of *crystalline picropodophylline.*

Preparations.

1. **Tinctura Podophylli Indici.**—1; Alcohol 90 per cent., 3. *Dose*, 5 to 15 min.
2. **Resina Podophylli Indici.**—A powdered resin obtained from Indian Podophyllum, and resembling Podophyllum Resin (page 218). *Dose*, ¼ to 1 gr.

ACTIONS AND USES.

Similar to those of Podophyllum (page 218). It is incompatible with ammonium preparations.

Sappan. — Sappan. (India, and Eastern Colonies.) The heartwood of Cæsalpinia Sappan. N.O. Leguminosæ.

Characters.—Hard, heavy sections or orange-red chips, showing well-marked concentric rings and rays; inodorous; taste astringent.

Composition.—Contains *sappanin*—a crystalline colouring matter resembling hæmatoxylin, and similar to or identical with *brazilin*, the colouring matter of brazil wood—and *tannin.*

Preparation.

Decoctum Sappan.—50; Cinnamon Bark, 8; Water, 1,000; 1 in 20. *Dose*, ½ to 2 fl. oz.

ACTIONS AND USES.

Sappan was used as a dye before the introduction of aniline dyes. It contains Tannic Acid; and when an astringent effect is desired, it is used to colour mixtures red.

Tinospora.—Tinospora. (India, and Eastern Colonies.) The dried stem of Tinospora cordifolia. N.O. Menispermaceæ. Collected during the hot season.

Characters.—Cylindrical, straight or twisted pieces, or in transverse sections; bark shrunken, longitudinally furrowed, and covered with round elevated scars; colour greenish-brown; not rough; odour not marked; taste bitter.

Composition.—Contains *berberine* (page 219), a *starch* known as *gilæ ka sat*, and a non-crystallisable bitter *glucoside*.

Preparations.

1. **Infusum Tinosporæ.**—1 in 10. *Dose*, ½ to 1 fl. oz.
2. **Liquor Tinosporæ Concentratus.**—10; Alcohol 90 per cent., 4½; Distilled Water, 20. *Dose*, ½ to 1 fl. dr.
3. **Tinctura Tinosporæ.**—1 in 5 of Alcohol 60 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

A simple bitter employed in malarial fevers (*see Bitters*, pages 220, 342, 473).

Toddalia.—Toddalia. (India, and Eastern Colonies.) The dried root bark of Toddalia aculeata. N.O. Rutaceæ.

Characters.—Quilled pieces, covered with soft yellowish periderm, fissured longitudinally, and exhibiting a bright yellow layer and a deeper brown layer; faint aromatic odour, and an aromatic, pungent, bitter taste.

Composition.—Contains a *resin*, an *essential oil* having the odour of cinnamon, and an *antipyretic alkaloid*.

Preparations.

1. **Infusum Toddaliæ.**—1 in 10. *Dose*, 1 to 2 fl. oz.
2. **Liquor Toddaliæ Concentratus.**—1 in 2·5 of Alcohol 20 per cent. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

A carminative allied to Cusparia (page 257). It is used as a stomachic and febrifuge in dyspepsia and dysentery, and as a stimulant in rheumatism.

Turpethum.—Turpeth or Turbith Root. White Nisot. (India, Eastern and North American Colonies.) The dried root and stem of Ipomœa Turpethum. N.O. Convolvulaceæ.

Characters.—In short pieces ½ to 2 in. in diameter, from which the central woody portion is usually removed. Externally dull grey, twisted rib-like or columnar; odour faint; taste nauseous.

Composition.—Contains 10 per cent. of a resin *turpethin*, a glucoside, allied to convolvuline (pages 349, 350). The resin is only found in the stem. *Dose*, 5 to 20 gr. in powder.

Preparation.

Tinctura Jalapæ Composita.—Jalap, 8; Scammony, 2; Turpeth, 1; Alcohol 60 per cent., 100. *Dose*, ½ to 1 dr.

ACTIONS AND USES.

The same as those of Jalap (*see* page 349).

Tylophoræ Folia. — Tylophora Leaves. (India, and Eastern Colonies.) The dried leaves of Tylophora asthmatica. N.O. Asclepiadaceæ.

Characters.—Petiolate, entire, 2 to 5 in. long, ¾ to 2½ in. wide; broad, ovate, abruptly acuminate, leathery; upper surface glabrous, lower downy; colour brownish-green; odour aromatic; tasteless.

Composition.—Contains *tylophorine*, a crystalline alkaloid. *Dose*, ¼ to 2 gr. as an expectorant; 15 to 30 gr. as an emetic.

ACTIONS AND USES.

Precisely the same as those of Ipecacuanha (page 318). Used with success in the treatment of dysentery.

Urginea.—Indian Squill. (India, and Eastern Colonies.) The younger bulbs of Urginea indica and of Scilla indica, N.O. Liliaceæ, taken soon after the plant has flowered.

Characters.—Bulbs of Urginea indica are tunicated, consisting of fleshy coats, varying greatly in size; colour whitish; taste bitter and acrid. The bulbs of Scilla indica are not tunicated like an onion, but made up of thick, fleshy imbricated scales.

Composition.—*See Scilla* (page 411).

Preparations.

1. **Acetum Urgineæ.**—2½; Diluted Acetic Acid, 20. *Dose*, 10 to 30 min.
2. **Oxymel Urgineæ.**—2½; Acetic Acid, 2½; Water, 8; and Liquid Clarified Honey, 27. *Dose*, ½ to 1 fl. dr.
3. **Pilula Ipecacuanhæ cum Urginea.**—1; Pulvis Ipecacuanhæ Compositus, 3; Ammoniacum, 1; Syrup of Glucose q.s. (1 of Opium in 20). *Dose*, 4 to 8 gr.
4. **Pilula Urgineæ Composita.**—1¼; Ginger, 1; Ammoniacum, 1; Hard Soap, 1; Syrup of Glucose, 1. *Dose*, 4 to 8 gr.

5. **Syrupus Urgineæ.**—Acetum Urgineæ, 20 oz.; Refined Sugar, 38 oz. *Dose*, ½ to 1 fl. dr.
6. **Tinctura Urgineæ.**—1 in 5 of Alcohol 60 per cent. *Dose*, 5 to 15 min.

ACTIONS AND USES.

Precisely the same as those of Squill (page 412).

Valerianæ Indicæ Rhizoma. — Indian Valerian. Tagar. (India, and Eastern Colonies.) The dried rhizome and rootlets of Valeriana Wallichii N.O. Valerianaceæ.

Characters.—A dull brown crooked rhizome about 2 in. long and ¼ to ½ in. diameter, with transverse ridges and circular prominent tubercles to which a few thick rootlets are attached. The crown has a number of bracts; lower end is blunt; odour characteristic.

Composition.—Contains a *volatile oil* consisting of valerianic and other organic acids (*see* page 324).

Preparation.

Tinctura Valerianæ Indicæ Ammoniata.—1 in 5. 4 oz.; Oil of Nutmeg, 30 min.; Oil of Lemon, 20 min.; Solution of Ammonia, 2 oz.; Alcohol 60 per cent., 18 oz. *Dose*, ½ to 1 fl. dr.

ACTIONS AND USES.

Precisely the same as those of Valerian (page 324).

Viburnum.—Black Haw. (India, Eastern and North American Colonies.) The dried bark of Viburnum prunifolium. N.O. Caprifoliaceæ.

Characters.—Thin pieces or narrow quills, glossy purplish-brown, with a few scattered warts and minute black dots; when collected from old wood, covered with a greyish-brown periderm which is easily removed; inner surface smooth, pale reddish yellow; fracture short; faint odour; taste somewhat bitter.

Composition.—Contains a glucoside *viburnin*, and *valerianic*, *tannic*, *oxalic*, *citric* and *gallic acids*. A definite active principle has not as yet been isolated.

Preparation.

Extractum Viburni Prunifolii Liquidum.—1 in 1 of Alcohol 70 per cent. *Dose*, 1 to 2 fl. dr.

ACTIONS AND USES.

Black Haw is used as an astringent and a nervine tonic. It is most useful in dysmenorrhœa, menorrhagia, and uterine disorders.

Part IV.

GENERAL THERAPEUTICS.

CHAPTER I.

INTRODUCTION: THE FOUNDATIONS OF RATIONAL TREATMENT.

THE terms THERAPEUTICS and TREATMENT, although they may appear at first sight too simple to call for analysis, include four different notions. These we must study individually.

1. **Health.**—The first notion involved in Treatment is a purely *physiological* one, the notion of *health* or the normal state, from which the organ has departed, and to which it has to be restored. Health is the result of a number of natural influences acting on the individual, namely, the intrinsic conditions which he brought into the world with him, and the extrinsic circumstances around him. It is important for the therapeutist to appreciate that these circumstances are continually varying, the temperature and other characters of the atmosphere, our food, in short our whole environment, being inconstant; and that in correspondence with and in obedience to these, the physiological state of the body is not a constant quantity. We speak of a "normal" state, and call it "health," but the first essential of life and health is a capacity of accommodation or adjustment to varying circumstances. When a definite change is thus produced on an organ by a natural force or substance—mechanical strain, electricity, nervous influence, food, drugs—it is called the "physiological action" of the influence.

2. **Pharmacodynamics: Physiological action.**—The second elementary notion in the expression "treatment" is, that man possesses a power of interference with nature or natural forces, that is with the conditions and circumstances of life; and in this way is in a position to exercise a certain control over the health or physiological state of the individual. He can alter the food we eat, the air we breathe, our clothing,

our sources of heat. He may admit into our bodies substances which he finds in nature—mineral, vegetable, animal, or others that are altogether artificial. On the other hand, we may voluntarily shun or reject such substances, and avoid many influences, whether good or bad, around us. To express this control which we have over our organs in health, through the influences to which we subject them, we say we *act upon them* by such and such means, or that such and such a substance has such and such *physiological actions.* This is the subject of *Pharmacodynamics*, or *Pharmacology* in the modern acceptation of the term.

3. **Disease.**—The conception of *disease* is also included in "treatment." When the influences round us become unusual or extraordinary, they cause disturbance of the vital processes. If this be moderate, it is still included under the name of "health;" but if it be considerable, it is called *disorder*, *disease*, or a *pathological process or state;* and the influences are said to be *morbid*, *morbific*, or *pathogenetic.* Pathological action is but a modification of physiological action in response to new, extraordinary, or morbific influences around or within the patient. It is impossible to draw a line between health and disease, just as it is impossible to divide influences strictly into salutary or physiological, and morbific or pathogenetic. The pulse is accelerated by joy, by wine, by fever; which of these conditions is health, which disease? All that can be said is, that the change from the normal state is frequently so definite that we cannot reasonably call it "health;" that we must find another name for it, and call it "disorder;" and if it be more marked and attended by suffering we call it "disease."

4. **Recovery.**—Successful treatment necessarily involves a *power of recovery.* The body possesses abundant provisions for preventing disease spontaneously, and for recovering from it without our assistance. This power of resisting, overcoming, and surviving morbific influences may be illustrated by a few instances.

(1.) The provisions which the physiologist calls *regulating mechanisms* are regarded by the pathologist and therapeutist as natural methods of *removing* or *counteracting* the causes of disease, or of affording relief from it. The stomach rejects a meal if it be too large or unwholesome. The heart unburthens itself of excessive peripheral resistance through the depressor mechanism. The body-heat is elaborately regulated by various nervous arrangements which prevent chill on the one hand and heat-stroke on the other hand, and are concerned in fever.

(2.) The normal blood contains chemical and biological elements which maintain health, prevent disease, and provide for recovery by *protecting* the body against micro-organisms and their products (immunity), or by actually *destroying* them (phagocytosis).

(3.) When taxed by more than ordinary mechanical influences like weight or increased resistance *a fronte*, the voluntary and involuntary muscles (such as the biceps and the heart) display more than ordinary activity by virtue of the *reserve force* which they possess, and so prevent injury or disease and counteract damage. Secreting organs and the brain behave similarly. But for this provision of *adaptation*, every organ would break down as often as an extra demand was made upon it.

(4.) Further, if this reserve force be constantly called into play by persistence or repetition of the increased stimulus, the increased activity gives rise to *hypertrophy* of the organ, and what is known as *compensation* is the result. This great natural method of prevention or recovery is well seen in disease of the heart, and in enlargement of the one kidney when the other is disabled.

(5.) In certain instances part of the work of a disabled organ is undertaken by another organ, which thus relieves it and the body as a whole. This is called *vicarious action ;* it is seen at work between the kidneys and the skin, and between the lungs and the heart.

(6.) Nature has also various ways of *relieving* pain and other forms of distress spontaneously by means of automatic rest, cubitus, muscular rigidity, etc.

(7.) Even when disease has led to anatomical change, the body possesses means of arresting hæmorrhage, and of *repair, of spontaneous limitation of the affected area, and of removal of the products and other effects.* These provisions are associated with increased nutritive activity and frequently with the process of inflammation.

Another important element of spontaneous recovery is the *natural cessation of many morbid processes* after either a definite or an indefinite course. This element is familiar in the eruptive fevers.

These considerations teach us that just as our organs continue normal in obedience to the laws under which they have reached their present form—health, so, if they have become disordered by morbific causes, they may return to the normal when the abnormal influences are removed, overcome or exhausted—recovery.

Therapeutics.—We now can appreciate the four foundations of rational therapeutics: (I.) The organs act in

obedience to natural influences in and around us; (II.) disorder and disease are but physiological phenomena or anatomical results of the disturbing actions of the ordinary or extraordinary natural influences; (III.) we possess a certain control of these influences; and (IV.) the functions of the organs, and it may be even their anatomical state, will return to the normal if the influences become normal. It follows (V.) that the art of therapeutics consists in controlling the natural forces which affect the human body injuriously or in counteracting or neutralising their actions and effects by other natural forces, until in either case nature returns to the normal. To effect this change is to *treat disease*. It is with this meaning that we shall speak of *rational therapeutics*.

1. **Preventive treatment.**—The science and art of preserving health are known as *Hygiene*, *Sanitation*, or *Public Health*. Manifestly this is founded on physiology. If we thoroughly understood physiology, and had unlimited power over the forces of nature, we might so preserve health that disease would be unknown. Unfortunately, we possess this knowledge and this power only in small measure. and hygiene is correspondingly imperfect; but as far as it goes, hygiene renders therapeutics unnecessary.

A second form of preventive treatment is *prophylaxis*. This is something more than simple hygiene, the preservation of health as it is: it recognises the causes of disease at work, and anticipates them. Prophylaxis is practised by avoiding pathogenetic influences or media, such as water poisoned by cholera or typhoid excreta, or by protecting ourselves actively, say by vaccination against small-pox, by taking quinine in a malarious country, or by drinking lemon-juice to prevent scurvy.

2. **Remedial treatment.**—When hygiene and prophylaxis are powerless or cannot be employed, the case comes into the hands of the practitioner. The body is disordered or diseased; now there is occasion for *therapeutics*, with a view to *remedy* or *relief*. This introduces us to our proper subject.

(*a*) *Attention to the cause.*—When we meet with a case of disease which we have failed to prevent, we still try to deal with *the cause*, and thus restore the normal state. We remove a foreign body from the finger, or a poison or indigestible meal from the stomach; we neutralise an acid by an alkali; we kill parasites. In doing so, we simply follow one of nature's methods.

(*b*) *Recuperative treatment.*—Our next concern is to promote recovery by controlling *the pathological processes* which have originated in the cause. These include the *destructive*

processes of degeneration, necrosis, ulceration, malignant growth, etc. ; the *reconstructive* processes of repair, hypertrophy, etc. ; and the many associated elements of disease—some morbid, some regenerative, others partly both, such as inflammation. This is the most extensive and important province of therapeutics, and affords opportunities of employing remedies of every kind. We order food; and then we say the treatment is **dietetic**. We change the atmosphere ; and then we say the treatment is **climatic**. We may employ the chemical and other substances contained in the Pharmacopœia ; then our treatment becomes **medicinal**. Or we may confine ourselves to **surgical** measures, or to **electrical, balneological,** or **general** treatment.

(*c*) *Palliative treatment.*—There are few diseases in which we have not to attempt to *neutralise or counteract* their painful, debilitating, or otherwise distressing *effects* on the body. Knowing the physiological action of many different measures, we select such as act in an opposite direction to the morbid cause, and employ them to counteract it ; anæsthetics or analgesics to prevent or relieve pain, hypnotics to produce sleep, stomachics to restore digestion, and so on. Palliative treatment is manifestly much inferior to recuperative. We strike not at the cause of disease, nor at pathological processes, but only at their effects. Still, even this limited power may be of great value ; and it is often urgently demanded in order to relieve distress and depression or avert danger. Sometimes it is all that is required—we may have to treat only the effect that persists after the morbid process has ceased. This kind of treatment sometimes is called **symptomatic,** and in certain circumstances **expectant** (*expectare,* to wait), the principle of which is to wait, and attend to the general physiological needs of the patient, whilst the disease runs a limited course, as in typhoid fever.

It is evident that we have in these different orders of treatment an enormous field for observation and application. If we could but find means, whether medicinal or not, to control each abnormal agent and condition to which the body is subject, we might defy disease. But here we are met by certain difficulties. Before we can hope to combat disease in this way, we must know : (1) all about disease and its causes, that is, we must have a perfect ætiology and pathology ; and (2) all about the actions of therapeutical agents upon the body, that is, have a complete pharmacology. Unfortunately, all three are far from being complete sciences. And there are other limits to treatment—in structural changes of the

body. If a limb be lost, we cannot restore it; if the mitral valve be covered with diseased growth, we cannot renovate it. But we are right when we maintain that these structural changes, grave or hopeless as they may be, are but results of the actions of causes which we shall yet discover and may be able to control. As pathology advances, we are learning more about the nature and origin of cancer, for which a limb has to be removed; more about rheumatism, which damages the cardiac valves.

The student is now in a position to consider the meaning of two terms connected with therapeutics—**rational treatment** and **empirical treatment.** Treatment is said to be *rational* when it is suggested by our knowledge of the medical sciences: it is founded on natural laws which are known and understood. *Empirical* treatment is founded on experience only, and conforms to no law yet known. It may be, and frequently is, as successful as rational treatment—sometimes even more so, *e.g.*, the treatment of Syphilis with Mercury; but whether successful or unsuccessful, we can offer no scientific reason for it. All that we can say is, that experience has proved incontestably that a particular drug or kind of treatment was beneficial in previous instances, and that *therefore* it probably will be beneficial again. We hope soon to know more about the various remedies that have been employed successfully; and as we acquire this knowledge, and are able to account for their effects, we shall transfer these remedies from the the group headed "empirical" to the group called "rational." Therapeutics will become perfectly scientific when empiricism has thus without exception given place to rationalism.

Plan of the following chapters.—In approaching the study of the general therapeutics of the different systems of the body, we shall adopt the following plan suggested by the preceding considerations: (I.) We shall give a brief sketch of the *physiological* relations of the system. (II.) We shall consider fully the *pharmacodynamics* of the same, chiefly dealing with the drugs examined in the previous parts of the work, but frequently referring to non-medicinal measures, such as food, air, exercise and baths. (III.) A rapid sketch will be given of some of the *pathological* relations of the system, those being selected which best serve to illustrate the actions and uses of remedies, *i.e.*, disorders or derangements rather than diseases of the parts. (IV.) A brief reference will be made to the evidence of *natural recovery* in the particular system, and to the failures of such attempts. (V.) The *rational therapeutics* of the system, founded on the previous four divisions, will complete the account.

CHAPTER II.

DIGESTION—THE MOUTH.

I. Physiological Relations

The process of digestion begins with the reception of food, more or less prepared by cooking. During its brief stay in the mouth, the food is triturated and mixed with mucus and saliva, and its starchy constituents are partly converted into maltose by ptyalin, and others of them are dissolved.

1. *Food* forms no part of the subject of the present work. We have only to remind the reader that the chief proximate principles of a proper diet are proteids, carbohydrates, fats, salts and water. The relative proportions of these constituents vary greatly in different kinds of food.

2. The *sensory nerves* of the mouth (the glosso-pharyngeal, and the lingual and other branches of the trigeminus) receive and transmit to the cerebrum and medulla the impressions of taste, as they are commonly called, whether sweet (the pleasant taste referable to amylolytic action), bitter, salt, sour, hot, burning, warm, pungent, acrid, or nauseous; and the many kinds of aromatic flavours, which are chiefly, however, odours. In the medulla the afferent —gustatory and sympathetic—impressions fall into a special centre, whence they are reflected as impulses (1) to the stomach, the functions of which they modify, as we shall see; and (2) to the salivary and mucous glands of the mouth, which they markedly influence, through the chorda tympani. Through the same efferent (secretory) nerves other impulses reach the mouth: from the cerebrum, as the result of the taste, smell, sight, or even idea of food; from the stomach, conveyed by the vagus; and, doubtless, from many other sensitive parts, especially in the abdomen.

3. The *flow of saliva and mucus* is the result of the nervous impulses which have just been traced, and which stimulate the protoplasm of the cells and actively dilate the vessels. Saliva is secreted at the commencement of digestion; is intimately mixed with the food; splits the starch into maltose and dextrin (which is subsequently converted into maltose also); and imparts to the bolus a faintly alkaline reaction which has an important effect on secretion in the stomach, as we shall see in the next chapter.

4. It is well to distinguish from the ordinary secretions of the mouth, the *excretions* which are also thrown out by the glands. Although these are but little appreciated in health, they are familiar as the source of certain unpleasant tastes in the mouth and odours of the breath, after particular kinds of food and drink, and many drugs such as Mercury and Iodine.

5. The *muscular acts* of mastication and swallowing are guided by the afferent impressions and by the will.

II. PHARMACODYNAMICS.

We come now to inquire, according to the plan which we sketched in Chapter I., whether we possess any means of influencing the physiological functions of the mouth, and if so, how far such powers can be employed usefully.

1. *Food.*—We have absolute control over our food. We can withhold it altogether; we can alter the quantity, kind and form of it as we please, or we may predigest it with Pepsin or Liquor Pancreaticus, and give artificially-prepared albumoses and peptones if natural digestion be imperfect or obsolete. Particularly as regards the mouth, we may modify the proportion of carbohydrates in the diet, affect their condition by cookery, or convert them wholly or partially into sugar before administration. Malt extracts chiefly consist of dextrin and maltose, made from malted grain and flour. The control which we thus possess over food is the foundation of the vast subject of dietetics.

2. The *sensory apparatus* in the mouth can be variously influenced. Stimulants of the nerves of the mouth prove to be more powerful and more useful pharmacodynamical measures than might be believed. First, they increase relish or the enjoyment of eating, and thus the appetite and the amount of food consumed. Secondly, they provide for the digestion of this increased quantity of nourishment by exciting the secretion of the digestive fluids in the mouth, and, as we shall see in the next chapter, in the stomach also. The variety of natural tastes and flavours of which we may avail ourselves is endless. Artificial products are hardly less numerous. The art of cookery is much concerned with the proper use of these; and so is the growth of wines. The many natural and artificial condiments, such as mustard, pickles and sauces, act chiefly upon the palate. Beyond the culinary art, an immense number of agents are contained in the materia medica which may be used in therapeutics proper, to act upon the tongue and palate, and thus upon the nervous centres and viscera. These may be arranged as follows: (1) The great group of warm **aromatic** oils, including

Cloves, Allspice, Peppermint, Rosemary, Lavender, Nutmeg, and many others, each with its own peculiar flavour; (2) **bitters**, such as Calumba, Quassia, Quinine, etc.; (3) **aromatic bitters**, of which Gentian, Orange and Cascarilla are examples; (4) the **spirituous** group, including Spirits, Wines, Chloroform and Ether; (5) **pungent** substances proper, such as Mustard, Horseradish and Pyrethrum; (6) **sweet** substances, including Sugar, Liquorice, Glycerin, etc.; and (7) **acid or sour** substances, such as the Mineral Acids, acid fruits, and Acid Tartrate of Potassium, to which we shall presently return.

The effect of such substances on the palate also affords us means of covering the tastes of nauseous medicines, of which we constantly avail ourselves. On the other hand, we may employ the unpleasant taste or flavour of certain drugs, such as Valerian and Asafetida, to produce a powerful influence on the sensorium through the afferent nerves.

3. *Salivary and mucous glands.*—Substances and measures which increase the flow of saliva are called **sialagogues** (σίαλον, saliva, and ἄγειν, to cause to flow), and include the greater number of the stimulants of the sensory apparatus just classified. Of these the most important sialagogues are unquestionably diluted acids, including the Diluted Mineral Acids, Carbonic Acid in effervescence, Vegetable Acids and their salts, wines (which are all acid to a degree), and acid fruits and juices, of which Lemon may serve as a type. The familiar effect of acid drinks in relieving thirst cannot, however, be entirely explained by their influence on the nerves of taste. Acids directly stimulate the salivary glands. Here the student is introduced to a physiological law which we shall frequently have occasion to notice: *that acid substances stimulate alkaline secretions, and alkaline substances stimulate acid secretions.* The action is probably a local one, the acid or alkali, as the case may be, being quickly absorbed, and reaching the protoplasm of the glands direct.

Other drugs act as *specific sialagogues* upon the terminations of the portio dura in the salivary glands, or on the cells themselves. Such are Jaborandi and its active principle Pilocarpine, Tobacco, Physostigma, Mercury and Iodine, and the indirect emetics Antimony and Ipecacuanha.

Opposed to these measures are the **antisialagogues**, equally at our service although but rarely employed. Such are *insipid or nauseous* articles of food or medicine, with which may be classed *depressing nervous influences;* dilute *alkaline* or soapy substances acting locally, such as Potash, Soda and Lime; and certain articles of the first importance

in the materia medica which act upon the secreting nerves, and may, therefore be called *specific antisialagogues.* The type of these is Belladonna (Atropine), with Hyoscyamus (Hyoscyamine) and Stramonium. Tobacco in excess has the same effect, as well as Opium.

If the natural secretion fail, certain *substitutes* for the mucus may be employed, which are called **demulcents** (*demulcere*, to soothe), as they sheathe the mouth, tongue, fauces and bolus with a protective coating. Such are simple drinks, especially warm water, toast-water, water and milk; mucilaginous preparations, including barley-water, gruel and linseed tea; Decoction of Ispaghula; preparations of gelatin and glycerin; lozenges made with gums; preparations of starch, eggs, honey and figs; palatable oils; syrups; and ice.

4. The *excretions* of the mouth also can be influenced by means of substances which are thrown out of the system by this channel, such as Iodine, Lead and Mercury. The therapeutist can hardly be said to avail himself of this means of acting on the mouth, except in the case of Potassium Chlorate.

5. The *mastication and insalivation* of the food also can be regulated, on the one hand by ensuring time and care in the process of eating, on the other hand by ordering such a diet as is entirely fluid or as may be thoroughly triturated and exposed to the juices of the mouth.

III. Pathological Relations

As has been already suggested, the pathological relations of the mouth and the first part of the digestive process, as far as we are concerned here, are of less interest in themselves than from their bearing upon digestion in the stomach and the further progress of the food.

1. We discover in the *food* the chief cause of all digestive disorders, whether it be unsuitable in kind, excessive in quantity, or taken at over-frequent or irregular times.

2. Loss of the *sense of taste* is familiar in fever, the result being arrest of the salivary flow and interference with relish and appetite, always a serious matter in such cases. Many diseases are attended with impairment or even loss of appetite. In this connection must be mentioned the unfortunate tastes of most drugs, the difficulty of their administration, and the degree to which they interfere with the appetite.

3. Disorders of the *secretions* of the mouth include chiefly disturbances of the quantity of saliva and mucus. The saliva is probably deficient in some cases of long-standing

indigestion; and the marked want of it in acute febrile conditions causes dryness of the tongue and mouth, thirst, loss of relish as we have just observed, and inability to swallow, the morsel being rolled hopelessly about the mouth. A somewhat similar condition may be induced by depressing emotions, such as fear or grief; and by certain medicinal or dietetic substances, including Belladonna, Opium and Alcohol. Excessive secretion of saliva and mucus ("salivation") was very frequent in the days when Mercury was regularly administered until the "gums were touched"; and is still occasionally seen from the same cause, as the result chiefly of accident or idiosyncrasy, or as the effect of Iodine or Potassium Iodide in similar circumstances. A *reflex* salivary flow of a very interesting kind occurs at the commencement of vomiting, and in some cases of gastro-intestinal disorder, constituting one form of "pyrosis" or "water-brash." In other cases salivation is produced by disease of the nervous centres.

4. Derangements of the *excretions* of the mouth are among the causes of the "bad taste" and unpleasant odour of the breath connected with digestive derangements; other important causes of the same being decomposition in the mouth, and excretion by the respiratory passages. Some drugs already mentioned have the same effect, such as Mercury, Iodine, Bromine, Lead and Paraldehyde; and the prevention of this unpleasant action may be a difficult task.

5. Second only to the food itself as a frequent cause of indigestion is the imperfect manner in which the *mechanical* processes in the mouth are performed, the solids being imperfectly masticated and insufficiently insalivated from hasty or careless eating, or from disease or actual loss of the teeth.

IV. Natural Prevention and Recovery.

We have next to inquire whether natural recovery, as defined by us in the first chapter, ever occurs in connection with the mouth and its functions. Observation places this beyond doubt in all the classes of disorder to which we have just referred. The sense of taste is restored after fever has gone. The secretions which have been deranged by the same cause, or by Atropine, Mercury or Jaborandi, return to their normal quantity and composition when the disturbing influence is spent or has been removed. The excretions again become "sweet" when the substance that disordered them has been completely thrown out. The teeth present side by side with decay a process of repair.

There is, however, a *limit* to recovery in the mouth, as elsewhere. The teeth decay and fall out; and the other tissues may become involved in serious disease. Even then, as we shall see presently, rational treatment is not impossible.

V. THERAPEUTICS.

The rational treatment of diseases originating in the mouth is but the scientific application of the knowledge arranged under the previous four heads, respecting its physiology, the influences acting on the mouth which are at our command, the causes and phenomena of its derangements, and the occurrence and limits of natural recovery.

1. The *food* must always receive most careful supervision, not only in cases where it has been bad, improperly taken, or imperfectly masticated, but in every instance of disorder of digestion from whatever cause, in the mouth or other part of the alimentary canal. The details of dietetic treatment must be learned from other works.

2. Disorders of the *sensory apparatus* of the mouth very rarely demand treatment for their own sake, but we have constant occasion to avail ourselves of our influence over the nerves of taste for the purpose of relieving derangements of the *secretions*. Thus deficiency of saliva, and the distressing thirst and loss of relish which attend it in fever, may be relieved either through the nerves of taste, or more directly by means of acid drinks—such as water acidulated with the Mineral Acids, Vinegar and water, Carbonic Acid in effervescing drinks, Cream of Tartar, Lemon Juice in various combinations—and by acid fruits, if not otherwise unsafe, including Tamarinds, grapes and oranges. Failing or instead of these, ice, sips of water, or some of the demulcents already enumerated may be given. When the deficiency of saliva, the dryness of the mouth, and the lack of relish are less urgent but more persistent, as in chronic dyspepsia and convalescence from acute disease, we have recourse to aromatic, bitter, spirituous and pungent articles. We order food specially flavoured or made otherwise agreeable to the palate by artistic cookery. When the appetite flags after severe illness or in exhaustion from other causes, we recommend the patient to stimulate his palate with a little wholesome wine which is at once acid, aromatic and spirituous. We rouse the nerves of taste and the secreting glands by simple or aromatic bitters in acid or alcoholic combinations before meals, or by pungent and acid condiments, such as mustard, pepper and pickles.

3. When it is desired to stimulate the gustatory and secreting functions of the mouth independently of digestion, *e.g.* in cases of paralysis of the mouth and in the chronic thirst of Bright's disease and diabetes mellitus, such substances as Pyrethrum, Tobacco, and small doses of Pilocarpine are indicated. The dryness of the mouth and throat caused by Atropine or Hyoscyamus may require suspension of the drug, or Jaborandi may be prescribed with it unless contra-indicated. On the other hand, salivation produced by drugs such as Mercury must be arrested by removal of the cause, or by the exhibition of Belladonna.

4. The treatment of unpleasant *excretions* from the mouth is rationally carried out by removing their cause, especially diseases of the teeth and gums and disorders of the stomach and bowels; by disinfecting and deodorising the breath; or by imparting to it an artificial odour.

5. Defects in the *mechanical apparatus* of the mouth, including the teeth, as a rule have advanced beyond the limits of functional treatment. Even then we can have recourse to dental surgery, one of the most rational and most successful branches of local therapeutics. Short of this, much can be done by ordering food in a soft or fluid form, and directing that time and care be spent by the patient over the process of masticating, tasting, and insalivating every morsel.

Lastly, a discussion of the action of drugs upon the mouth introduces us naturally to the therapeutics of the next stage of the digestive process—in the stomach. The substances which stimulate the nerves of taste are constantly employed, as we shall see, to produce reflex activity of the gastric functions; and the thorough insalivation with the alkaline juices of the mouth, for which they also provide, may be used as a powerful means of increasing the acid secretion.

CHAPTER III.

DIGESTION (*Continued*)—THE STOMACH.

I. PHYSIOLOGICAL RELATIONS.

GASTRIC digestion is mainly effected by the gastric juice, an acid secretion which owes its solvent and chemical power to pepsin and hydrochloric acid. The gastric secretion is stimulated by the first *products* of digestion, part of which is rapidly absorbed; by gustatory and other impressions on the *nervous centres*, referred to in Chapter II.; and by the contact of saliva and other *dilute alkaline fluids* with the mouths of the tubules. During digestion the gastric vessels actively dilate, and the muscles move vigorously. By the end of four hours much of the proteids have become soluble diffusible peptones (after curdling in the case of milk); fats are broken down; more of the starch has been chemically altered by the saliva incorporated in the food; cane sugar is inverted; any putrefactive organisms in the food are mostly destroyed; and the products, constituting the chyme, are transferred to the duodenum.

The arrangement by which the stomach is stimulated, or, in other words, prepared to receive and digest food, is partly a local one: the food, particularly certain of its constituents, the first products of digestion, and the alkaline action of the bolus excite the local nervous structures, the muscular coats, and the secreting glands themselves. Besides this, however, the stomach is connected with a regulating *centre* in the medulla and with the cerebrum, by means of afferent and efferent nerves—the sympathetic and vagus. The impressions which reach the sensorium and the gastric centre from the stomach are reflected as *impulses* through the efferent fibres; which also convey from the cerebrum impulses generated by sensations of taste, as well as by the smell, sight or idea of food, as we saw in Chapter II. Besides these, numerous impressions from the intestines, liver, kidneys and generative organs, indeed from all impressionable parts whatsoever, influence the stomach by being reflected to it through its centre in the medulla. The nervous impulses affect the secreting glands, the vessels, and the muscles—exciting, arresting, or otherwise modifying their actions, as the case may be; and in certain circumstances they give rise to vomiting.

II. PHARMACODYNAMICS.

We have now to inquire how many of the conditions which influence gastric digestion are under our control: how far we can act physiologically on the stomach.

1. We have complete power over all that enters the stomach in the form of *food* and drink, and much influence over salivary digestion, as we have seen in Chapter II. Even if the food have left the mouth and reached the stomach, we can evacuate its contents by means of the tube, or by the use of emetics, which will be considered in Chapter IV. Finally, food can be withheld entirely from the stomach, and alimentation carried on *per rectum* for weeks on end.

2. As regards the *gastric juice*, we can increase its flow in many ways. We can stimulate the tubules by the character of the food we order. We may provide, as the first part of the meal, substances, such as soup, which will be absorbed rapidly and excite the follicles to abundant secretion. We can subject the secretion to nervous influences which are at our command, such as the agreeable sensations of taste, which are aroused by artistic cookery, wholesome condiments and grateful wines, as well as many pleasing associations during meals. The activity of the glands may be increased through the medium of the local circulation, by various means to be presently described. The acid secretion is excited by moderate alkalinity of the contents of the stomach. This end may be secured by increasing the salivary flow, as we saw in Chapter II.; more certainly by the administration of dilute alkaline solutions before meals, such as Sodium Bicarbonate, Sal-volatile, or Liquor Potassæ, which are amongst the most useful and most generally employed of this class of remedies—the **alkaline stomachics.** We may go even farther than this, and modify the amount either of the pepsin, of the hydrochloric acid, or of both, by giving them along with the food, thus constituting them **digestive adjuvants.**

3. The activity of the *nerves* of the stomach is readily influenced in either direction. We stimulate them by administering the series of hot substances which we studied in the mouth, such as Alcohol, Volatile Oils, Pepper and Mustard. These substances, as well as the aromatic bitters, including Gentian and Orange, and the simple bitters such as Calumba and Andrographis, have the effect of dilating the vessels, and possibly of increasing the activity of the glands and muscles of the stomach, whilst they create a sensation of hunger, probably by setting up these changes in the gastric

wall. They form, therefore, other groups of stomachics: the **spirituous, pungent, aromatic,** and **bitter stomachics.**

Equally powerful is the influence of many substances and measures, as **gastric sedatives,** in reducing the excitability of the afferent nerves, and thus interfering with gastric sensations and the gastric functions which depend upon the reflection of impressions. Opium is thus all-powerful in preventing or relieving pain in the stomach, and in arresting the gastric secretions and movements. Diluted Hydrocyanic Acid and Belladonna and its allies also act in this way; as well as Carbonic Acid in the form of effervescence; Water, either as hot as it can be drunk or in the form of ice; Bismuth, whether mechanically or physiologically; and Oxalate of Cerium in a manner which is still quite obscure. A number of drugs remove causes of irritation, and are thus gastric sedatives, such as Silver Oxide, Creosote, and Carbolic Acid, which arrest disorder of the mucous membrane or modify the contents. Various applications to the epigastrium, including poultices, fomentations and blisters, afford a convenient means of soothing the gastric nerves reflexly through the nervous centres. The sense of hunger may be appeased by tobacco-smoking.

4. The *circulation* in the stomach is also so far under our control, as we have already seen. The many substances which stimulate the nerves also redden the surface of the mucous membrane, dilating the vessels, increasing the local blood flow within physiological limits, and giving rise to a sense of warmth in the epigastrium. Such are Alcohol, Ether, Chloroform, Aromatic and Pungent articles (Pepper, Mustard, Capsicum, etc.), and Bitters. Besides these, there are numerous substances of a more powerfully irritant nature which we note chiefly for the purpose of suggesting caution in their employment for other purposes. Arsenic, Iron, Mercury, and indeed the salts of most of the metals; Senega, Digitalis and Scilla; Colchicum and Veratrine, are examples of drugs that are specially apt to derange digestion. On the other hand, the local circulation can be rendered less active by means of Acids; by Salts of Silver, Zinc and Lead, in small doses; by Ergot, Opium, Tannic Acid and the many vegetable astringents containing it, such as Kino, Catechu and Cinnamon. These are **gastric astringents,** and indirectly, therefore, another class of *gastric sedatives.*

5. The *movements* of the stomach can be readily modified. The energy of the churning movements increases with the acidity of the chyme, and we can take advantage of this knowledge by administering acids after meals, such as

Diluted Nitric, Hydrochloric or Nitro-hydrochloric Acids, which are thus another class of *gastric stimulants*, sometimes called **gastric** or **stomachic tonics**. Specific nervo-muscular stimulants, such as Strychnine, probably act in the same way, as well as the stimulants of the nerves and vessels, especially Ether and Volatile Oils. That peculiar excitation of the movements of the stomach which is called emesis or vomiting will be specially described in Chapter IV.

Per contra, the gastric movements may be directly diminished by Diluted Hydrocyanic Acid, Opium and Morphine, Carbonic Acid and all effervescing drinks; by the Alkalis, which reduce acidity; as well as indirectly by remedies which soothe the nerves and the vessels, as we have seen, and others that we shall meet with in our study of vomiting.

6. We have already referred to our influence on the *contents* of the stomach—to the food, and to the acidity of the chyme. The reaction may be neutralised or completely changed by Alkalis or Alkaline earths, which are thus **antacids**. Beyond these, Charcoal absorbs the gaseous products of digestion; whilst Mercurials, Sulphurous Acid, Sulphites and Thiosulphates, Phenol, Sulphocarbolates, Creosote, the Aromatic Oils, and possibly all Bitters and Vegetable Astringents in some degree correct decomposition—**gastric disinfectants**. In this connection mention must be made of many **antidotes** which act upon poisons in the stomach.

7. *Action of carminatives.*—The effects of Aromatic and Pungent Oils, of Alcohol and Ether, in rousing the nerves of the stomach, in increasing the activity of the gastric circulation, in exciting muscular contraction, and in modifying the contents, have been separately described; and they probably relax the cardiac orifice at the same time. The result is eructation and relief of gaseous distension, of cramps and cardiac failure, the whole being so striking and complete that these substances have been grouped together under the special name of **carminatives** (*carmino*, I soothe). Their effect is, however, more than local. The nervous impressions produced by carminatives spread beyond the stomach and its sympathetic ganglia to the cord, medulla and brain, and are reflected thence to the vessels, heart and other viscera. Gastric stimulants thus come to be general stimulants of both the bodily and the mental functions, and carminatives are one form of *diffusible stimulants*.

8. In conclusion, let us note the significance of *rest* of the stomach, secured by any of the preceding means, especially by withholding food entirely. The peristaltic movements

and those of the two orifices do not occur; the gastric juice does not flow; the circulation is relatively inactive; the walls of the stomach are not stretched mechanically by ingesta nor by the gaseous and other products of chemical decomposition, and absorption necessarily is absent.

III. PATHOLOGICAL RELATIONS.

Derangement of gastric digestion, or dyspepsia, is probably the most common disorder of the human body, and may be taken to illustrate, in a general way, the rational treatment of diseases of the stomach.

By far the most frequent causes of derangement of the stomach are to be found in the quantity and characters of the food; in its imperfect mastication and insalivation; in excess of fluids, which dilute the gastric juice and check secretion; and in the abuse of alcohol. Certain drugs in common use also cause indigestion, such as Opium, Arsenic, Iron, Digitalis and Squill. Structural disease of the stomach itself necessarily leads to the same result. Excess of the gastric juice is sometimes met with, but as a rule the juice is deficient in relation to the amount of food taken, whether from excess of the latter or from absolute diminution of the secretion—for instance, in debility after illness. Again, either the pepsin or the hydrochloric acid may be deficient, or impeded in its special action. Gastric indigestion is occasionally of nervous origin: depressing mental states readily arrest the action of the stomach; and morbid impressions originating in the liver, intestines, kidneys or uterus may have the same effect reflexly.

Disorder of the muscular functions of the stomach may also cause dyspepsia. Feebleness of the churning movements leads to imperfect exposure of the food to the action of the juice; feebleness of the expulsive efforts delays the removal of the chyme, *excess of which arrests digestion.* In other cases, excessive peristalsis hurries the food into the duodenum before the process of gastric digestion has well commenced.

If from any of these or from other causes the contact of the food and the gastric juice be deficient, the process of digestion becomes disturbed. The secretion, unable to effect complete conversion of the proteids into peptones, produces some partial chemical change in them; the other constituents of the food are also broken up; and—what with the unnatural products, and, in the case of a heavy meal, the excess of peptones themselves—the process of digestion is completely arrested. A decomposition occurs associated with

the formation of organic acids; the sugar, starch and fat probably become partially changed; and the contents of the stomach are converted—not into the normal chyme, but into a sour, fermenting mass with abundant development of gas. The stomach becomes distended, and the neighbouring organs impeded in their action, especially the heart. The nerves, vessels and glands of the stomach are irritated by the products; the mucous membrane swells; the rosy hue passes into pallor; the surface is coated with a tenacious mucus. Distress is felt in the epigastrium. The gastric and associated centres are powerfully excited; and impulses are sent out which lead to hiccup, eructation and vomiting. If these do not give relief, the contents pass into the bowel, irritate it also by their excessive acidity and decomposition, and give rise to duodenal dyspepsia and diarrhœa. Even when the urgent symptoms have subsided, the morbid anatomical condition remains for a time, associated with a profuse secretion of mucus; the digestive power is arrested; pain and fulness are felt; and loss of appetite (anorexia) and nausea are complained of. All these effects will call for relief by treatment.

In *chronic dyspepsia* the attacks are much less severe, but practically continuous. This may depend on improper food and feeding; on structural disease of the stomach, such as cancer; on nervous disorder; on disease of other organs, *e.g.* the kidney, or of the system generally, such as gout. The muscular power of the stomach often becomes weak in chronic dyspepsia, the peristaltic movements are less vigorous, the organ is dilated, and the actions of the orifices are variously disordered, with flatulent distension as the result.

Structural diseases of the stomach, such as ulcer and cancer, call for notice here only in as far as they illustrate the need for gastric rest, which prevents and relieves distress, particularly pain, checks the pathological processes and promotes repair.

IV. Natural Prevention and Recovery.

The stomach possesses a series of natural provisions for preventing, resisting, or recovering from disease. Satiety checks over-eating and drinking. Indulgence is met by reaction on the part of the gastric walls and follicles, which respond in due proportion to the demands on their activity, and may successfully accommodate and deal with an unnecessarily large meal. Hyper-acidity of the contents of the stomach, whether by secretion or by decomposition, is automatically relieved by reflex salivation. Greater excess provokes vomiting obviously a natural provision for relief;

and the subsequent anorexia and nausea prevent the introduction of more food, and afford the stomach temporary rest, which has a restorative effect on all its functions. In structural diseases of the gastric walls, such as ulceration, the great methods of natural recovery are found at work: repair, hypertrophy, and accommodative dilatation. Further, acute gastric catarrh generally runs a natural course, in so many hours or days if left entirely without treatment. These are valuable suggestions for treatment, of which the thoughtful practitioner avails himself with success. The duration and degree of suffering in acute indigestion may, however, be considerable; and the violence of the symptoms, such as vomiting, may lead to injury or permanent disease. Therapeutical interference is therefore essential. Structural diseases of the stomach are frequently beyond treatment in themselves, but most of the distressing symptoms by which they are attended are easily relieved.

V. THERAPEUTICS.

The conclusion to be drawn from the considerations in the preceding sections is manifestly to the effect that certain disorders and diseases of the stomach can be treated rationally.

1. *Prophylactic treatment.*—Prevention is essentially the proper means of treating dyspepsia. Just as the common causes of gastric disorder are constantly at hand, so is the opportunity of removing or avoiding them. Prevention here lies almost entirely in the direction of diet, and includes care with respect to the quantity, kind and form of the food; the frequency and general arrangement of the meals; the circumstances, social and otherwise, in which the food is taken; the thorough performance of the functions of the mouth; the amount of fluids, including alcohol, consumed with meals; and other matters which do not call for discussion here. *Dieting is the most important part of the treatment of indigestion:* without attention to it medicinal treatment is of no avail.

Next to the food, the most ready, but not the most advisable, means of preventing dyspepsia in persons liable to it is furnished by the gastric juice itself (*i.e.* its important constituents) artificially administered. Hydrochloric Acid and Pepsin may be given alone or combined, either during or immediately after meals; or the food may be previously peptonised by the addition to it, in the process of cooking, of a digestive extract made from the mucous membrane of the stomach or from the pancreas of the calf or pig.

The therapeutist should endeavour, however, to adopt a much less artificial method of treatment than this. He should try to call into play some of the influences to which the gastric flow is peculiarly sensitive, and thus to increase the natural juice, instead of borrowing its constituents from other sources. First, he will ensure a certain mechanical effect of the food on the stomach, by seeing that "slops" are not indulged in, at the same time remembering that a small quantity of a warm nutritive fluid dish, such as clear soup, which will stimulate the mucosa and be quickly absorbed, is the best commencement of a considerable meal. Drugs also will be prescribed. Medicinal stimulants of gastric activity must reach the stomach just before food. Those which increase the activity of the nerves and vessels, and indirectly the activity of the glands and muscles, namely alcoholic, aromatic, bitter and pungent stomachics, are best given in combination, *e.g.* the tinctures of Gentian, Orange, Cascarilla, Chiretta, etc., variously combined with spirits such as Spiritus Ammoniæ Aromaticus, Spiritus Myristicæ, Spiritus Armoraciæ Compositus or Spiritus Chloroformi. A still more powerful gastric stimulant is to be combined with these, viz. an alkaline stomachic, in the form of a preparation of Potassium, Sodium or Ammonium, the Sodium Bicarbonate being, for many reasons, the salt most frequently selected. Let it be carefully noted that the alkali must be given, with the aromatic bitters, *shortly before meals*. This constitutes the routine medicinal treatment of dyspepsia, and we may repeat that the same result is obtained by successful insalivation of the food, of which the method is but an artificial imitation. The mental occupation and general surroundings of the patient, as well as the times and amount of physical exercise with relation to meals, will also require to be carefully regulated.

2. *Remedial treatment.*—If acute dyspepsia be actually present, it is too late to attempt to stimulate the gastric flow. We must make our choice whether we shall evacuate the stomach, or neutralise the acidity and absorb the gas which are causing the distress. The use of emetics will be described in the next chapter. If the alternative measure be chosen, we give a dose of alkali or an alkaline earth; not, let it be observed, as an alkaline stomachic, but purely as an *antacid to the contents* of the stomach. Sodium Bicarbonate is again the means commonly chosen for the purpose, combined probably with Ammonium Carbonate and an aromatic oil, such as Peppermint or Ginger, or more elegantly with Spiritus Ammoniæ Aromaticus, to act as a carminative. The

result is that the acidity of the contents is reduced—and it is remarkable how small may be the quantity of alkali required for this purpose—so that the mass passes with comparative safety into the duodenum. Instead of Soda, Magnesia or its Carbonate is occasionally used as an antacid, which, being also a purgative, hastens the expulsion of the offending contents. Gas may be partly absorbed by charcoal, given in powder or in the form of lozenges or biscuits, partly removed by eructation induced by the carminative, which will further help to arrest decomposition, relieve pain, and rouse the heart and nervous system from the state of depression caused by the attack.

3. *Treatment of the effects.*—When the process of indigestion is at an end, and prostration still has to be relieved, the therapeutist will avail himself of some of the many gastric sedatives at his disposal, of which Diluted Hydrocyanic Acid, Bismuth and Morphine (whether given subcutaneously, applied to the epigastrium endermically, or combined in an effervescing mixture) will be found the most useful. Champagne or effervescing Soda Water and Brandy will serve at once as a gastric sedative and a general stimulant, or Milk with Lime Water or Soda Water may be given as a sedative and nutritive, but only the smallest quantity can be borne. Ice or sips of water as hot as it can be taken are the best means of relieving thirst and act also as a sedative. Linseed poultices, hot fomentations or warm compresses may be ordered to the epigastrium, and in severe and persistent cases Mustard or Cantharides blisters. The chief problem will be to give sufficient food to support the strength without increasing the pain and sickness, and in very urgent cases the patient must be fed by the rectum.

Caution must be exercised in resuming gastric digestion. The best dietetic treatment of acute dyspepsia is to rest the stomach absolutely for many hours, unless the patient be prostrate. Anorexia conduces to this end. The first food should be given in the smallest possible bulk, and be of the blandest and most digestible kind, such as broths, meat juices, or peptonised milk. Presently solids may be permitted; and then a small dose of mixed stomachics, such as Sodium Bicarbonate, Diluted Hydrocyanic Acid and a mild aromatic bitter like Gentian, should be given before meals, in order to re-establish the secretion.

4. *Chronic dyspepsia* is rationally treated on the same principles as the acute form of the disorder, with certain modifications which a careful consideration of the pathological associations of the particular case and general experi-

ence will suggest. The patient's diet and times and manner of meals will require strict and constant supervision; and test-meals may have to be given. The possible causes of indigestion, besides food, must be searched for, such as diseases of the teeth, disorder of the liver, bowels or uterus, disease of the heart or kidneys, gout or tuberculosis; and treatment arranged accordingly.

The flow of juice usually requires stimulating with Alkalis, combined with different stomachics, and given just before meals. Pepsin and Diluted Hydrochloric Acid may be brought to the relief of the failing secretion in some instances; but an effort always should be made to restore the gastric functions by means of stomachics rather than to supplant it with digestive adjuvants. In still more chronic cases, *e.g.* in aged persons, where chronic indigestion depends on wasting of the glandular structures, peptonised foods will be of great service. In most cases of chronic dyspepsia the nervo-muscular structures of the stomach require to be strengthened, and distension or overfulness of the organ avoided. Flatulent substances must be excluded from the diet, such as green vegetables, sweets, sloppy food, or large draughts of strong, hot tea; and fluids may have to be forbidden at meal times. Powerful bitters, such as Strychnine and Quinine, the former being peculiarly valuable as a specific nervo-muscular stimulant, and Diluted Nitric and Phosphoric Acids—in short, *stomachic tonics*—are given to increase the functional and nutritive vigour of the muscular coat. In some of these cases *gastric disinfectants*, such as Carbolic Acid, Creosote, Mercurials, and the Sulphites or Thiosulphates, may be required to cleanse the contents and surface of the organ and destroy the organisms of putrefactive and fermentative processes; or the stomach may be washed out systematically (*lavage*). Carminatives afford relief of flatulence, distension, and associated oppression of the heart.

Chronic dyspeptics always suffer from starvation to a degree, and the food selected for them, since it is strictly limited in amount, must be nutritious as well as digestible. Alcohol in proper form and amount may be permitted, and bland preparations of Iron, such as the Ammonio-citrate, ordered at intervals, if they can be taken without increasing the dyspepsia. If the dyspepsia depend on a chronic catarrh of the stomach with excessive secretion of mucus, *gastric astringents* may sometimes be indicated, such as Silver or Zinc Oxide, or Kino, Cinnamon and other substances containing Tannic Acid.

The treatment of *structural diseases* of the stomach cannot be discussed here, but it is hoped that the student will understand, from what he has learned, the principles which he must follow to fulfil the most urgent indications in this class of cases also: to promote repair, to relieve pain and sickness, and to insure functional rest of the stomach and of the body as a whole, which greatly promotes both of these objects. It is of the first importance to save the stomach the mechanical irritation of ingesta, to prevent circulatory excitement and the flow of gastric juice (which actually digests an open sore on the mucosa), to arrest the peristalsis of the walls with its damaging and painful effects on the diseased area, and the rhythmical movements of the pylorus, which is the commonest seat of structural diseases. In such cases the necessary degree of gastric rest is secured by regulating the diet in amount, kind and form; and in extreme instances by rectal alimentation, or by the operation of gastro-jejunostomy, which renders the pylorus obsolete and thus sets it entirely at rest.

The therapeutics of vomiting, and incidentally of certain other associated disorders of the stomach, will be discussed in the next chapter.

CHAPTER IV.

EMETICS AND VOMITING.

I. Physiological Relations.

Vomiting is a complex act, in which the respiratory muscles, the larynx, the abdominal walls, the walls of the stomach, the sphincter of the cardiac orifice, and the œsophagus and pharynx participate. Occasionally it is to be regarded as a strictly physiological process for removing excess of food from the stomach, as in the regular sickness of infants after a full meal of milk. It is determined and directed by an elaborate nervous mechanism, consisting of a special centre, the *vomiting centre*, in the medulla; of *afferent nerves* from the fauces, stomach, abdominal viscera and peritoneum (the chief of which are the glosso-pharyngeal, the fifth, the vagus and sympathetic), and, indeed, from other parts of the body —the sensory nerves generally; and of *efferent nerves* (the vagus, phrenic and intercostals) to the muscles, cardiac orifice, and certain associated parts to be presently mentioned. Vomiting may be induced by impressions originating in the areas supplied by any of the afferent nerves; by stimulation of the centre by certain substances which reach it through the blood; or by the downward flow to the centre of certain mental impressions, such as nauseous tastes, foul odours, disgusting or terrifying sights and depressing ideas.

With the evacuation of the stomach there occur certain *associated acts* which are of great importance to the therapeutist. A flow of saliva may precede vomiting, as is well seen in some reflex cases. The gall bladder may be forcibly emptied of bile, which regurgitates into the stomach and is vomited. Expiratory movements, such as sneezing and coughing, frequently occur at the beginning of sickness, indicating the spread of the stimulant impulses to the associated respiratory centre in the medulla; and it must be carefully observed that an expiratory effect is also produced by compression of the chest during evacuation of the contents of the stomach, and forcible expulsion of the air through the larynx at the end of the act, to prevent the entrance of foreign particles. Thus vomiting tends to empty the respiratory

passages as well as the upper part of the alimentary canal. The stimulant effect of emetics on the salivary flow is frequently accompanied by a secretion of bronchial mucus; and this, being expelled by the upward current of air, clears the passages still further.

Whilst the respiratory and gastric centres are thus powerfully stimulated in vomiting, the cardiac and vascular centres are greatly depressed, the action of the heart and the pulse being reduced in force—at least between the acts of sickness—and a sense of faintness and giddiness overspreading the patient from further cerebral anæmia. At the same time the motor centres in the brain, and probably in the cord, are lowered, leading to prostration and inability to support the weight of the body, and compelling recumbency. Lastly, the centres of perspiration are stimulated, causing the profuse sweating familiar in many cases of sickness. Altogether, the student will appreciate how extensive is the physiological disturbance produced by vomiting, and how great is the influence which it affords us over several of the most important functions of the body.

II. PHARMACODYNAMICS.

Vomiting may be *excited* by certain substances and measures, which are called **emetics.** Emetics are said to be (1) **direct,** when they act upon the stomach itself; (2) **indirect,** when they act upon the vomiting centre or some other part of the nervous mechanism; (3) **direct and indirect,** when they act upon both. (1) *Direct* emetics are the largest of the three classes. They include *warm* water, an infusion of Chamomile, Salt and Water, Mustard, Ammonium Carbonate, Zinc Sulphate, Alum, and Copper Sulphate. Necessarily they are given by the mouth. (2) *Indirect* emetics are a small group of drugs, including Ipecacuanha, Tylophora, Antimony and Apomorphine. These excite vomiting by whatever channel they may be admitted into the blood—subcutaneously, by the mouth or by the rectum. For the same reason they produce greater general depression, that is, depress the other vital centres in the medulla more than moderate doses of the direct emetics. Physical irritation of the fauces is a ready emetic measure of the indirect class; and nauseous drugs, such as castor oil and rhubarb, frequently act on the nerves of the same part, but are not given with this intention. (3) Ipecacuanha, Tylophora and Antimony act on the stomach as well as on the centre, and are really, therefore, *direct and indirect* emetics.

The means at our disposal for *averting or arresting vomiting* are as various as the parts of the extensive mechanism upon which they act. They may be called **anti-emetics.** First of these may be mentioned the measures which *reduce the excitability of the vomiting centre*, such as the recumbent posture, nourishing food, Amyl Nitrite, Nitro-glycerin, Alcohol, Opium, Chloral Hydrate, the Bromides, and Diluted Hydrocyanic Acid. A second class, more readily available, comprises the *sedatives of the afferent nerves* from the stomach, such as *hot* Water, Ice, Diluted Hydrocyanic Acid, Carbonic Acid in effervescence, Bismuth, dilute Alkalis, Opium, and Ipecacuanha and Calomel in small doses; measures that act *indirectly* upon the stomach and reduce the excitability of its nerves, such as poultices or blisters to the epigastrium; and *sedatives of the afferent nerves to the vomiting centre from other organs*, for instance, demulcents to the throat, poultices to the abdomen, or applications to the os uteri.

III. Pathological Relations.

Vomiting being regarded for our present purpose as a physiological act, it may be considered to be disordered either (1) if *excessive;* or (2) if *defective, insufficient or absent* when it would be salutary or desirable. We shall illustrate each of these conditions.

1. *Excessive vomiting* is a result of disorder or disease of the stomach; of morbid conditions of other parts of the abdomen—such as hernia, gall stones, and renal or uterine affections, as well as pregnancy; of cough; of severe pain; of injury or disease of the brain; or of disturbance of the circulation and senses, *e.g.* in sea-sickness. The cause of vomiting may be in the centre itself, especially as a consequence of previous violent vomiting, or of the action of certain extrinsic poisons, such as antimony.

2. *Defective vomiting* may be said to occur when only attempts at retching ensue on direct or indirect excitation of the vomiting centre. In the vast majority of cases, however, we have to deal with conditions in which, whilst vomiting is urgently demanded, no spontaneous attempt at vomiting is made, the substances which require to be expelled from the stomach being of a non-irritant or even sedative nature, such as narcotic poisons. This introduces us, further, to the use of emetics for other purposes than simple evacuation of the stomach. Vomiting may be desired for the sake of obtaining one or more of the associated effects on other viscera. In certain inflammatory diseases of the

larynx and bronchi, such as croup and bronchitis, which are attended with the production of thick or solid products, and in whooping cough, which is characterised by defective or disordered expulsive power, an emetic may be indicated to empty the respiratory passages and restore free entrance of air. Emesis may be used to empty the gall bladder and biliary passages. Some obstetricians have held that rigidity of the cervix uteri in labour calls for emetics, to relax the sphincter.

IV. NATURAL PREVENTION AND RECOVERY.

As we have seen, vomiting is essentially a provision for removing certain causes of disorder and disease in the alimentary canal; and also of eliminating some dangerous products of disease—particularly in connection with the respiratory organs and kidneys. With the removal of its cause it usually ceases, but it may persist indefinitely, until the therapeutist steps in. There is a limit to its beneficial effect. Protracted vomiting appears to increase the irritability of the mucous membrane and nerves of the stomach, and of the vomiting centre, which may become so hypersensitive that the smallest amount of food or even the slightest change of posture brings on fresh sickness. There is urgent need for treatment in such cases.

V. THERAPEUTICS.

The therapeutical relations of vomiting, rationally considered, are obvious. Excessive vomiting has to be arrested; vomiting may have to be assisted when it is ineffectual, or excited when desirable but entirely absent; and the action of emetics may be taken advantage of for other purposes than to empty the stomach.

1. *Excessive vomiting.*—The study of the physiology and pathology of vomiting serves to impress upon the student the absolute necessity for diagnosis, or investigation of the cause of a disorder, before rational therapeutics can be carried out, and the thoroughly unscientific and unsatisfactory character of the practice which applies treatment to symptoms without ascertaining the pathological condition on which they depend. How extremely irrational it would be to attempt to relieve by the same means the vomiting caused by indigestible food at the commencement of acute gastric catarrh, and the vomiting due to the swelling which persists in the second stage. At the former period, vomiting is relieved by temporarily encouraging it with a good emetic; at the second

period, the very opposite set of measures—gastric sedatives—must be employed.

The first step to be taken manifestly is to attempt to *remove the original cause* of the reflex act. If the stomach contain the products of indigestible food, the acidity must be neutralised, as we saw in Chapter III.; if a poison, some antidote must be administered immediately; or either of the two irritants may be removed from the stomach by facilitating and completing vomiting, or by means of the stomach pump. Once emptied, the stomach must be quieted by the gastric sedatives already studied. If the cause be discovered in any of the other abdominal organs, the same plan of removal must be pursued if possible, *e.g.* by operation, or with a purgative such as Calomel. Vomiting originating in injury or disease of the brain will call for the special treatment proper in such cases, and the free use of cerebral sedatives, such as the Bromides of Potassium and Ammonium. If the vomiting centre is being irritated by some intrinsic poison as in uræmia, or by an extrinsic poison such as antimony, the excretion of the morbid substance by the kidneys, skin or bowels must be hastened, or its effects antagonised. On the other hand, when disturbance of the circulation in the centre is the cause of vomiting, we must restore the normal supply of blood by keeping the patient in the recumbent posture and ensuring bodily rest; and stimulate the circulation by Alcohol and food, if they can be retained in the stomach. Trinitrin, Amyl Nitrite and Chloral Hydrate appear to have been given with some success in these circumstances.

When *the cause cannot be removed* we must reduce the irritability of the afferent nerves or centre with Morphine hypodermically or other sedative drug, insure rest, and resume feeding with particular care.

In all cases of severe and persistent vomiting, food and the methods of feeding come to be a subject of consideration and possibly of concern. Highly nutritious foods—natural or artificial—in small quantities frequently repeated, or nutritive enemata (*see* page 506) have to be employed.

2. *Defective vomiting: use of emetics.*—The adoption of vomiting as a therapeutic measure, and the selection of an emetic from the list just given, are matters of great practical importance. The student must not think that in inducing vomiting we are effecting a simple mechanical act of evacuation: he must appreciate the extent and degree of physiological disturbance which we are setting up. If the patient be very weak, the therapeutist may be alarmed to find that his emetics or unsuccessful attempts at emesis are followed

by intense circulatory depression, faintness, and even threatening dissolution. The condition of the patient must be carefully, if quickly, ascertained; and if vomiting be considered a justifiable and proper method of treatment, a selection must be made of an emetic, according to the patient's strength and other circumstances. Fortunately, in most cases of acute poisoning where vomiting is urgently indicated, the patient is able to bear the shock, and Zinc Sulphate twenty grains in two ounces of water, Copper Sulphate two to five grains in an ounce of water, or a tablespoonful of Mustard in a cupful of warm water, should be given without delay. Where blocking of the respiratory passages by the products of croup or bronchitis calls for an emetic, great judgment is required to estimate the patient s strength and to select a proper emetic, if any. Vinum Ipecacuanhæ, in doses of 1 fl. dr. for children, or ½ fl. oz. for adults, is the best, because it is also an expectorant. Antimony is decidedly more depressing, in doses of 1 to 2 gr. of Tartarated Antimony, or ½ fl. oz. of Vinum Antimoniale, for an adult. Carbonate of Ammonium in 30 gr. doses is a suitable emetic in these cases, being a stimulant to the heart and respiration. In acute dyspepsia the mildest emetics are indicated, including tepid water with a little Sodium Bicarbonate, Salt and water, or warm nauseous infusions such as Chamomile; they may be given freely. Apomorphine is the most certain and most generally applicable but the least employed of emetics, because rarely at hand; $\frac{1}{16}$ gr. may be given subcutaneously, or a dose of $\frac{1}{8}$ gr. by the mouth. Tylophora Leaves in doses of 15 to 30 gr. are used in India and Eastern Colonies. It is frequently necessary to follow an emetic by a stimulant, such as alcohol.

CHAPTER V.

DIGESTION (*Continued*)—THE DUODENUM.

WE are now in a position to follow the process of digestion in the duodenum. The other functions of the intestine will be considered in the next chapter.

I. PHYSIOLOGICAL RELATIONS.

The chyme passes out of the stomach with an acid reaction, and its undigested constituents are at once subjected to a second process of digestion in the duodenum by an *alkaline* fluid, which is a mixture of the pancreatic juice, the bile and the enteric juice. The pancreatic juice, in association with the succus entericus, converts the remaining starch into maltose, and the remaining proteids and the proteoses into peptones, leucine, tyrosine and simpler products. In association with the bile, it partly emulsifies, partly saponifies the fats; and these are further altered by bacterial action. The carbohydrates are partly converted into lactic, carbonic and butyric acids by putrefactive bacteria, which also decompose proteids. The succus entericus inverts cane sugar and maltose into glucose, and is also amylolytic. These products of duodenal digestion (as well as those of gastric digestion), part of them as such, part of them resynthesised by the villi into proteids and fat, along with the salts and water, are absorbed into the portal and lacteal systems; whilst the undigested portions of the food and various excretions are further acted on by the bowel, and become fæces.

Just as the acid gastric juice was stimulated to flow by the insalivated food and its alkaline reaction, so the three great alkaline secretions entering the intestine are stimulated to flow (whether directly, or indirectly through secretin), by the acid chyme in the duodenum. Moderate acidity of the contents, as they leave the stomach, is manifestly most favourable to intestinal digestion: excessive acidity would neutralise the alkaline fluids and render them inert.

The nervous mechanism which regulates each of the three secretions is comparatively obscure; but they appear to be governed, like the gastric functions, by centres in the medulla, between which and the viscera there pass the sympathetic and vagus, as afferent and efferent nerves. The vessels of the parts, as far as is known, are dilated during functional activity. The muscular movements are still, as in the stomach, partly progressive and partly churning, but the former decidedly preponderate.

II. Pharmacodynamics.

In pursuing the contents of the alimentary canal from the stomach into the duodenum, the pharmacologist becomes conscious of a decided loss of control over them when they have passed the pylorus. The chyme is now practically beyond recall upwards by vomiting; and the chemical or physiological effects which could be produced by drugs in the mouth and stomach can be copied but imperfectly in the intestine. Yet a closer examination of the influences on duodenal digestion that are in our power is reassuring.

The *food* can be modified in any direction we may think proper. The proportion of fatty and starchy principles can be specially arranged to affect intestinal digestion; the liver, pancreas and duodenal glands may be permitted physiological rest by abstinence from eating. The food may be specially cooked in combination with an extract of pancreas and an alkali, and thus thoroughly pancreatised or peptonised before it is taken. Starch may be partly converted into maltose and dextrin—so called Extract of Malt. If evacuation of the duodenum by the mouth be practically impossible, we may expel its contents downwards by the use of purgatives, which will be presently studied.

A more complex problem meets us when we attempt to affect the *secretions* of the liver, pancreas and intestinal glands. We cannot increase the alkalinity of the secretions directly, as we increase the acidity of the gastric juice by a dose of diluted hydrochloric acid after meals: any alkali given by the mouth is neutralised in the stomach before it reaches the duodenum. For the same reason we cannot administer pancreatic juice by the mouth as we give pepsin: its ferment is destroyed at once in the stomach. Malt extract contains an amount of active diastase, which also, however, is destroyed in the stomach, unless the extract be given at the very end of gastric digestion, when the acid is exhausted. We do possess, however, equally physiological if less direct

means of increasing duodenal activity. First, by influencing gastric digestion we can transmit the chyme into the duodenum with greater acidity, an **indirect duodenal stimulant** measure. Secondly, acids, such as Diluted Nitric, Nitro-hydrochloric or Phosphoric Acid, given after meals, will be conveyed in the chyme to the mouths of the ducts, and act as **direct duodenal stimulants**; and it is possible that these may have a further influence in the same direction by being absorbed from the stomach and reaching the liver and pancreas through the blood. On the other hand, an alkali given before meals will stimulate duodenal digestion by improving gastric digestion; whilst an alkali given after meals would interfere with duodenal digestion by diminishing the natural and necessary acidity of the chyme—unless this be excessive.

We have a considerable number of substances which increase the flow of bile, and are designated **cholagogues.** Cholagogues are either *direct*, when they act upon the liver itself; or *indirect*, when they stimulate the liver by sweeping the bile out of the gall-bladder, bile-ducts and intestine. These facts may be accepted temporarily in connection with the digestive function of the bile; they will be fully discussed along with the purgative function of the bile in the sixth chapter. Mercurials not only clear the duodenum of chyme and bile, and furnish it with a supply freshly secreted, but also disinfect it, and thus check the putrefactive flatulence of digestion. They probably also stimulate the duodenal glands. Ether stimulates the pancreas, and probably assists in emulsifying oils.

III. Pathological Relations.

Duodenal dyspepsia is not uncommon, and may be either *secondary* or *primary*. The *secondary* form is a necessary consequence of gastric indigestion. The acid decomposing mass which passes the pylorus in acute gastric catarrh completely neutralises the alkaline secretions of the duodenum; the remaining proteids, fats, starches and sugars undergo further decomposition, instead of the proper chemical transformation; absorption is arrested; the peristaltic movements are unnaturally increased; and the contents are hurried through the bowel and violently expelled—the whole constituting the diarrhœa of acute indigestion, familiar to all. At the same time, pain is felt in the abdomen as the result of the powerful impressions on the afferent nerves, attended by a sense of misery and depression. *Primary* acute duodenal catarrh closely resembles the disorder just described, except

that it is not preceded by gastric symptoms; and it constitutes another form of diarrhœa. As in the case of the stomach, the chief cause of the derangement is improper feeding, including excess of those principles which tax the activity of the liver and pancreas, namely, fats, sugars and (in infants) starchy materials. In other instances the bile may be deficient as well as the flow of the pancreatic juice. Nervous and mental depression also interferes with the action of the secreting glands, and may lead to indigestion and diarrhœa.

In chronic duodenal catarrh disturbance of the natural relations between the digestive juices and the chyme produces less urgent symptoms, but leads to more serious impairment of nutrition. Pain, "heart-burn" and depression come on within a few hours after meals. The bile papilla and ampulla of Vater are invaded; the bile-ducts and pancreatic duct are partially blocked by swelling of the mucosa; and the bile and pancreatic juice enter the bowel in insufficient quantity. The bowels are irregularly moved; the motions are pale and foul, and may contain undigested fat and milk. The same symptoms in an aggravated form accompany structural disease of the duodenum, liver and pancreas. Disorders and diseases of the liver have, however, an interest much beyond their bearing on digestion, and will be separately discussed.

IV. Natural Recovery.

Little requires to be said under this head. Diarrhœa may be regarded as a natural provision for relieving the duodenum of unsuitable contents, as vomiting relieves the stomach. Even if diarrhœa be excessive, and give rise to general disturbance, the duodenal function soon becomes normal when the cause of disorder has been removed. A thorough appreciation of all the facts of the case manifestly suggests that the province of the therapeutist is not to prevent or check this salutary effort unless excessive: indeed it may be to encourage or assist it. In acting thus, and by withholding all food for a time, to afford rest to the bowel, he will promote more speedy and more sure recovery.

V. Therapeutics.

The rational treatment of disorder of the duodenum, as of the stomach, is either *preventive* or *remedial*. Duodenal dyspepsia may be prevented from returning, in persons predisposed to it, by careful regulation of the quality, quantity

and preparation of food. The patient must be ordered to eat sparingly, in particular of fatty, sweet and starchy foods, and to avoid richly cooked dishes, which generally contain fats in various stages of chemical decomposition. In extreme cases it may be necessary to ensure the digestion of a mixture of the proximate principles of a healthy diet, such as milk and bread or gruel, by peptonising them with Pancreatic Solution before they are eaten. Malt extract, which supplies sugar in a form ready for absorption and little liable to fermentation, will be suitable in some cases, but attention must be paid to the time of its administration with relation to meals. Next to food, the therapeutist will do wisely to attend carefully to the gastric functions, remembering that it is in this way that he will most rationally restore the chemical and physiological balance in the upper part of the intestine. He may elect to give an alkali shortly before meals to secure this end, or he may prefer to administer acids after meals, according to the directions already given under the head of gastric digestion. He increases the acidity of the chyme in the former instance physiologically; in the latter instance by simple chemical means. Alkaline mineral waters (Vichy, Ems, Carlsbad, etc.) are useful in chronic duodenal catarrh.

The *remedial* treatment of an attack of *acute* duodenal dyspepsia will generally follow, as we have seen, upon the treatment of acute indigestion in the stomach. We have studied the beneficial effect of neutralising the excessive acidity of gastric dyspepsia by means of an alkali combined with a carminative and stimulant; and it is obvious that this will be continued after the chyme has left the stomach. When treated with a full dose of Sodium Bicarbonate and Sal-volatile, the chyme enters the intestine with an acidity probably below the normal, reduces the higher acidity of the irritant chyme already there, and thus restores the normal action of the glands. If we are called too late to relieve duodenal indigestion by these means, the most rational course that we can adopt is to clear away the offending contents by purgation. Magnesia or its Carbonate acts well in these cases, being immediately antacid and afterwards laxative. More frequently a simple cholagogue purgative should be administered, such as Calomel, which has the further advantage of not disturbing the stomach by its taste or bulk.

Any pain and excessive muscular movements (colic) which may remain must be treated by sedative remedies, such as Opium or Bismuth. The treatment of diarrhœa and the uses of cholagogues and purgatives in chronic duodenal disorders are reserved till the next chapter.

CHAPTER VI.

THE INTESTINE.

We proceed to the consideration of therapeutical methods founded on a more complex physiological basis, namely, the actions and uses of *purgatives and intestinal astringents.*

I. Physiological Relations.

As the chyme passes along the small intestine, the chyle and other constituents are absorbed, and what remains is moved onward into the great intestine, where it forms the bulk of the fæces. Along the whole route, fluid is passing in both directions between the intestinal contents and the blood —from the bowel into the vessels, and from the vessels and glands into the bowel. The consistency of the fæces will, therefore, depend upon the activity of absorption, the activity of excretion, and, manifestly, the rate of transit. The more active absorption, the less active excretion, the slower the rate of transit, so much the firmer will be the fæces; whilst liquidity of the fæces will be the result of imperfect absorption, excessive excretion or rapid transmission. We are accustomed to speak of the one extreme as constipation; of the other as diarrhœa.

Absorption from the bowel is carried on by the lacteal and portal systems. The great bulk of the proteids, resynthesised from their own digested products, glucose, salts and water, are absorbed into the portal blood by a selective action of the epithelium, associated with diffusion. The activity of this process varies greatly: with the amount of water, salts, and peptone in the bowel, as compared with the blood plasma; with the chemical nature of these salts; with the rate of the circulation through the veins—that is, with the state of the liver; and with the condition of the epithelium, lymphoid tissue and membranes through which the fluids are admitted.

Excretion is so active in the small intestine that the fæces are as liquid at the ileo-cæcal valve as in the duodenum, *i.e.* the effect of absorption as regards the bulk of water is neutralised. The watery excretions, along with a small quantity of solids and gases, are separated from the blood, partly by osmosis from the vessels, partly by the glands, the

latter furnishing the succus entericus. The activity of the glands is doubtless dependent upon many influences connected with their vessels and nerves, and with the quality of the blood. These are still imperfectly understood.

The *transit* of the contents of bowels is effected by peristalsis. The muscular coat is innervated by the vagus and splanchnics, the former increasing the peristalsis of the small intestine, the latter tending to restrain or inhibit it, just as the vagus inhibits the heart. Whilst the intestine is connected by these means with the cord and brain, its movements are chiefly automatic. The state of tension of the wall, the internal pressure of fæces and gas, is the ordinary local stimulus of this mechanism; but the nerves or muscles, or both, are also stimulated by the bile; and may be either excited or depressed by many substances introduced through the blood, as we shall see under the next head, as well as (inversely) by the amount of blood supplied to them. In defæcation the will comes to the assistance of the automatic intestinal movements, and effects evacuation of the bowels.

General effects of evacuation of the bowels.—The effects of evacuation of the bowels are by no means purely local. On the contrary, the whole system is influenced by this act—to no great extent, it is true, in normal circumstances, but very markedly when it amounts to actual purgation. When the bowels are very freely moved, a certain amount of water is directly or indirectly removed from the circulation. Bile is swept out of the bowel, and the liver indirectly stimulated. Certain solids and gases excreted by the intestinal wall, that is, truly excrementitious substances, are thrown out of the system. The circulation in the abdomen is disturbed; the vessels are relieved from the pressure of the fæces; the blood flows more freely from the arteries into the portal system and liver; and whilst the volume of blood passing through the portal system and liver is temporarily increased, the volume of its water is reduced by the excretion. The heart and vessels generally are thus relieved; the blood pressure in the systemic arteries falls; the cerebral circulation is especially depressed on account of its position, so that faintness may result; the respiratory movements become easier; the activity of the venous circulation is increased; and the temperature falls. Of the abdominal vessels, the circulation through the renal artery and vein is increased, whilst the pressure in the ureters is lowered; thus diuresis may be more readily induced after purgation, unless the quantity of water drained off by the bowel have been excessive.

II. PHARMACODYNAMICS.

The means at our command of acting physiologically upon the intestine are of a much more artificial kind than any we have yet encountered, and introduce us to a large number of medicinal substances.

1. *Food.*—The influence of the food is felt in the bowels, and affords us a ready means of acting upon them. Many kinds of food increase the action of the bowels, notably coarse, indigestible articles of diet, such as the husk of cereals made into "brown bread" and "whole-meal"; green vegetables; oils; fruits, fresh or preserved, which contain abundant salts and sugars; soups, broths and other preparations of meat; eggs; ale and beer; tea and coffee, when properly prepared; and water taken at bed-time, or in the early morning before breakfast. On the contrary, cold articles of food, milk, spirits, red wines, and strong tea and coffee are constipating in their effects. Perfect *digestion*, in the mouth, stomach and duodenum, is one of the surest means of preserving or restoring the natural action of the bowels.

We pass from these common means of acting upon the bowels to others of a medicinal character, the precise actions of which are still imperfectly understood.

2. *Measures which act upon the intestinal blood-vessels: drastics; astringents; constringents.*—A number of substances disturb transudation by acting upon the *blood-vessels* in the intestinal walls.

a. Drastics.—These injure the epithelium, cause the vessels to dilate, and retard the blood current, so that the fluid constituents and part even of the solid constituents of the blood escape into the walls and cavity of the bowel. In other words, they establish an inflammation of the mucosa, somewhat resembling a common "cold" in the nose. The result is similar in the two cases: there is a profuse watery discharge from the mucous membrane, constituting a "catarrh," and producing in the case of the bowel a very liquid stool. The drugs which act in this way are obviously powerful or even dangerous, and comprise chiefly Croton Oil, Elaterin, Gamboge and Colocynth. They form a group of purgatives known as **drastics** (δράω, I act) or **drastic cathartics** (καθαίρω, I cleanse).

b. Intestinal astringents.—Opposed to these measures, we possess certain substances which contract the walls of the intestinal vessels, reduce the quantity of watery exudation, prevent the escape of solid elements, and thus diminish the liquidity of the fæces. Such substances include

Lead, Silver, and the Diluted Mineral Acids, and constitute the first group of **intestinal astringents**, called *intestinal vascular astringents.*

c. Intestinal constringents.—On the other hand, certain substances coagulate or otherwise condense the gelatiniform and albuminous tissue supporting the small vessels of the mucosa, increase its compactness, diminish the freedom of the circulation, and thus reduce the amount of exudation through the vessel walls. These **intestinal constringents** are a very large group, including Ferric salts, Alum, Copper Sulphate, Zinc Oxide, Tannin and the many vegetable products which yield it or some of its modifications, such as Catechu, Kino, Krameria, Butea Gum, Myrobalans, and Cinnamon.

3. *Measures which influence absorption and excretion.*—*a. Saline purgatives.*—Certain salts possess the property of greatly disturbing the *process of diffusion* in the intestinal wall, such as Magnesium, Sodium and Potassium Sulphates; Sodium Phosphate; Potassium Tartrate and Acid Potassium Tartrate; and Tartrate of Sodium and Potassium. These produce two effects, namely, first, an increased flow of secretion from the intestinal structures into the cavity of the bowel, and consequently increased liquidity of the stools; secondly, a flow of the salt, with a certain amount of water, from the cavity of the bowel into the blood-vessels, whence it is partly carried away into the general circulation, and partly again excreted into the bowel by the intestinal glands, once more to be absorbed. The result of this complex action is an abundant liquid stool; in the case of Acid Tartrate of Potassium, or very large doses of the other salts, almost entirely watery. The precise way in which these effects are produced by saline substances is still obscure. They appear to be due in part to the difference in specific gravity between the watery materials in the bowel and the liquor sanguinis, in part to some specific action of the salts upon the structures of the walls through which they pass, depending on their chemical constitution, or, stated otherwise, to some selective power resident in the lining epithelium. According to other authorities, saline purgatives act partly by increasing peristalsis—even when given intravenously or hypodermically; and we have seen that they also stimulate the glands. These salts furnish us with a ready means of increasing the liquidity of the motions and the frequency of the stools, and constitute the group called **saline purgatives**, the most powerful of which are called *hydragogue salines.*

b. Saline astringents.—A sufficient amount of salts and (within broad limits) a particular strength of solution are

required to secure an abundant secretion; otherwise their absorption in watery solution is stimulated beyond their excretion, and constipation instead of relaxation is the result. The same effect is liable to be produced by their habitual employment. We do not use this group of measures therapeutically.

4. *Measures which influence the intestinal glands.*—*a.* The secretions of the intestinal glands are moderately *increased* by Mercurial preparations; greatly increased by Croton Oil, Elaterin, Colocynth, Jalap, Scammony, Kaladana, Turpethum, and Podophyllin, which no doubt also act upon the vessels and muscles. Jalap and Scammony require to be dissolved in the bile. We have just seen that the saline purgatives are also glandular stimulants, being no sooner absorbed than they are again excreted. This class of purgatives may be called **cathartics**; such of them as produce very watery motions, **hydragogue cathartics.**

b. Opium, Lead and Lime directly *diminish* the intestinal secretions and promote constipation. Alkalis, Alkaline Earths and their Carbonates interfere with the acidity of the chyme when given in full doses, and thus indirectly reduce the intestinal secretions; whilst, by conversion into sulphates in the bowel, they may become active purgatives. Thus certain saline substances may not only be purgative in more than one way, but may even be purgative and astringent at the same time; the one effect or the other occurring according to the dose, the patient, and other circumstances which are still obscure.

5. *Measures which influence the nervo-muscular structures.*—Many medicinal substances influence the bowels through the *muscular coat*, the *nerves*, or both. Thus drastics excite intestinal peristalsis and griping even before they have left the stomach, *i.e.* reflexly, as is seen in Croton Oil. Saline purgatives are believed to have the same effect. It is practically convenient to arrange in a special class those substances which act entirely or chiefly upon the intestinal muscles:—

a. Nervo-muscular intestinal stimulants.—These include Rhubarb, Senna, Aloes, Castor Oil, Sulphur, Nux Vomica (and Strychnine), Cascara Sagrada, Belladonna, and many others. They are best given with carminatives, to prevent the intestinal pain caused by excessive or spasmodic muscular contraction, popularly known as "griping," which they readily induce. Belladonna appears to act in a different way from the others, by reducing the inhibition of the splanchnic; ergot by causing anæmia of the muscles. The stool which follows the action of a muscular stimulant is much less

watery than that produced by drastic, saline or cathartic purgatives, being chiefly the ordinary contents of the small bowel hurried down, unless the drug be given in large doses. For the same reason the disturbance of the portal circulation, the liver, the general circulation and the system as a whole is less marked. The nervo-muscular stimulants are therefore known as **simple purgatives**; and the mildest of them, such as Castor Oil and Sulphur, Figs and the like, are classed by themselves as **aperients** (*aperio*, I open), or **laxatives** (*laxo*, I loose), which induce a simple opening or relaxation of the bowels.

b. Nervo-muscular intestinal sedatives.—The drugs which *arrest* the movements of the bowel, either directly or through the nerves, include Opium, Morphine and Lead, which diminish peristalsis, and may even completely paralyse the bowel. Antacids and substances that form a protective lining on the mucosa produce the same effect indirectly by diminishing the irritant action of the contents. Chalk, Lime, the Alkalis and Bismuth act partly at least in this way. All these drugs are therefore called **astringents.**

6. *Cholagogues.*—Following naturally on the last class of purgatives comes a group which act indirectly upon the muscular coat by increasing the flow of the bile. These substances are known as **cholagogues** (χολή, bile, and ἄγω, I cause to flow). As will be explained in the next chapter, they either act directly upon the liver cells—**direct cholagogues**; or they sweep out of the body what bile is lying in the gall-bladder, bile-ducts and intestine, and thus indirectly stimulate a fresh secretion—**indirect cholagogues.** Direct cholagogues may be illustrated by Podophyllin, Rhubarb and Sodium Sulphate; indirect cholagogues are chiefly Mercurials. It will be observed that cholagogues and purgatives have complex associations with each other: most purgatives are probably indirect cholagogues; many purgatives happen to be also direct cholagogues; and all cholagogues exert a certain amount of purgative effect, inasmuch as they increase the flow of the bile.

We do not deliberately employ **anticholagogue** measures for *checking* the flow of bile. Opium possesses this action.

7. *Intestinal Disinfectants.*—A small number of drugs disinfect the contents of the bowels, or the walls of the bowels, or both. They include the salts and other preparations of Mercury, Bismuth Salicylate and Salol, Naphthol, Thymol, Oil of Turpentine, Camphor and indeed all aromatic volatile oils, and Charcoal. Carbolic Acid, the Sulphocarbolates and Chlorine are doubtful intestinal disinfectants.

Enemata (ἐνίημι, I inject).—Many of the remedies just mentioned, as well as others, may be administered by enema, that is, injected into the rectum. (1) Food, such as beef tea, peptonised preparations of meat, peptones, eggs, gruel and milk, and alcoholic stimulants, constitute **nutrient and stimulant enemata**. (Nutrient *suppositories* are also in use.) (2) Intestinal stimulants may be given as **purgative enemata**: chiefly Castor Oil, Olive Oil, and also enemata containing Aloes and Magnesium Sulphate. (3) An enema of Opium is a most valuable **sedative and astringent** preparation. Solutions of Zinc or Copper Sulphate, Silver Nitrate, Alum and a decoction of oak bark are also astringent. The bowel may be mechanically emptied by (4) **simple enemata,** such as warm water, warm soap and water, and thin gruel, which soften the fæces and stimulate the parts. Besides these we employ (5) **anthelmintic enemata,** which remove worms, such as an enema of Turpentine or of Aloes, and enemata of bitter infusions, or salt and water. Ice-cold water may be injected into the rectum as an (6) **antipyretic enema,** *i.e.* to reduce the temperature, and as a (7) **styptic enema** in hæmorrhage. (8) **Disinfectant enemata** are in common use, Boric Acid being the chief constituent. (9) **Enemata of normal saline solution** are given in collapse.

III. Pathological Relations.

As far as our present purpose is concerned, the disorders of the intestine, independently of its digestive function which has been already discussed, are chiefly two, namely: excessive action, the striking phenomenon of which is *diarrhœa;* and defective action, characterised by *constipation.*

1. *Excessive intestinal action.*—Simple catarrhal diarrhœa, as we have seen, is generally associated with gastric or duodenal dyspepsia. The ultimate cause is most commonly improper food, and the many irritant substances which may be admitted along with it, particularly the organisms of putrefaction. The same is seen in the gastro-enteritis of artificially fed infants, and in typhoid fever, dysentery and cholera. Irritant poisons have a similar effect. Certain intestinal irritants are generated in the body itself, such as urea and the poison of gout (chiefly uric acid). In all these instances the abnormal condition, referable to injury of the intestinal walls, is more than increased nervo-muscular activity: it is a form of catarrh, or other form of inflammation. Nervous disturbances also may produce diarrhœa, for example, anxiety and fear, apparently by disturbance of the vascular, muscular and secreting functions. Disorders

of the general and abdominal circulation are frequently attended by a watery flow or flux from the bowels, as in diseases of the liver and heart, or as the result of chill. Lastly may be mentioned structural diseases of the intestines. The student must note carefully that diarrhœa, although of much importance in itself and as a cause of further disorder, is but a symptom, the pathological condition on which it depends being different in different instances.

In connection with excessive activity of the intestines there may be associated conveniently for pharmocological discussion certain morbid conditions, such as hernia and perforation of the bowel, in which any peristaltic movement of the intestine, however slight, is excessive because highly dangerous, and in which temporary rest of the intestine is urgently indicated.

2. *Deficient intestinal action.*—Constipation is even more common than diarrhœa, and is peculiarly apt to appear in a chronic form. Of its causes, we may select as illustrative examples certain kinds of food already noticed; chronic gastric and duodenal dyspepsia, especially in connection with biliary disorder; sedentary or careless habits; and certain specific substances, such as lime and lead, admitted in the food or otherwise. Habitual constipation is generally due to loss of irritability and vigour of the nervo-muscular structures from very chronicity of the state and neglect of regular defæcation; to impairment of the general health by sedentary occupations, impure air, etc.; to a variety of obscure causes, commonly referred to as locality and change of habits; and to certain structural diseases of the bowel. The severest and most obstinate cases of constipation are caused by paralysis of the bowel in disease of the spinal cord and by lead poisoning. Although constipation, like diarrhœa, is but a symptom, and must be treated as such, its unfavourable effects on digestion, sanguification and the functions generally are almost endless.

Along with constipation must be considered pharmacologically a class of cases where disease of the digestive organs, liver, heart, lungs, general circulation, brain, blood or kidneys demands evacuation of the bowels, and, it may be, even a hydragogue or cathartic action, chiefly as a means of unloading the circulation or of evacuating excrementitious substances. Frequent reference will be made to this application of purgation under the several organs in the following chapters.

The *diseases* of the bowels are of great variety and complexity, and do not call for discussion in this Manual, except

as far as their morbid effects take the form of the disturbances of intestinal action just described.

IV. Natural Prevention and Recovery.

Diarrhœa is a striking instance of natural prevention and recovery by removal of the cause. Not only is the bowel purged of irritant and septic substances by this means, but constipation may be relieved naturally by a spontaneous diarrhœa following the irritant action of retained fæces. Both diarrhœa and constipation, if left entirely to themselves, may cease spontaneously, and the normal action of the bowels return. But therapeutical assistance always is valuable; often it is essential. Thus the diarrhœa of infants may end quickly in fatal exhaustion, and dilatation with atony of the gut may be the result of neglected constipation. Structural diseases of the bowels present the usual resistant and reparative processes characteristic of inflammation, although the destructive element is commonly in the ascendant, constituting ulceration, which is liable to lead to peritonitis. Under these circumstances relief from pain and therewith rest of the affected parts are secured automatically by diminution or cessation of the respiratory movements of the abdominal muscles, whilst reflex hardening of these affords protection to the underlying viscera against pressure. In chronic intestinal obstruction the reserve energy of the muscular walls is evoked, and this increased reaction leads to hypertrophy of the bowel above.

V. Therapeutics.

1. *Excessive intestinal activity; treatment of diarrhœa.*—The treatment of diarrhœa should begin, if possible, with *the removal of its cause.* If this is being accomplished by the bowel itself, we must encourage intestinal activity for a time by such purgatives as Castor Oil, Rhubarb, Calomel, Magnesia and Senna. The first two drugs are specially valuable, as they also possess an astringent action, which comes into force after the purgation. On the same principle, diarrhœa from hepatic or renal disorder or disease is rationally treated by non-interference or even by a judicious increase of elimination through the bowel, hepatic and renal stimulants being also combined; that is, by the use of a purgative which is partly cholagogue, followed by a diuretic—a mercurial pill supplemented by a Seidlitz powder. Or the cause may be *neutralised:* diarrhœa due to acidity in the duodenum is rationally treated with an alkali or alkaline earth, such as

Lime Water, Chalk or Sodium Bicarbonate, a highly successful method in the intestinal dyspepsia of infants. Improper feeding, *e.g.* in infantile diarrhœa, and in structural diseases of the bowel, such as typhoid fever, dysentery, tuberculosis and appendicitis, is stopped. If the cause cannot be removed it may be *destroyed in situ* with one of the intestinal disinfectants.

To *remove the effects of* the irritant influence, astringent measures are employed. The kinds of astringents in general use for this purpose are the constringents and the nervo-muscular intestinal sedatives. Of the former, Tannic Acid is less often used than its allies, between which there is little to choose, such as Catechu, Kino and Krameria. With the constringent there is usually combined some preparation of Opium as a nervo-muscular sedative, in the form of Dover's Powder, Kino and Opium, or Compound Opium Powder, which relieve pain, diminish the peristaltic movements, check the secretions, and arrest the cramps or tormina. It will be found desirable, in almost every case of diarrhœa demanding immediate arrest, to combine a certain amount of Opium, however small, with the other drugs; but this invaluable drug is often abused by being employed too early or in excessive doses. We are now in a position to understand the use of the intestinal *vascular* astringents: Lead, Silver and Diluted Sulphuric Acid. These are specially indicated in inflammatory conditions of the bowel, such as accompany ulceration in typhoid fever, dysentery and tuberculosis. Diluted Sulphuric Acid is given when the effect is intended to be speedy and brief. A small quantity of Opium or Morphine is again a powerful adjuvant; for instance, as the Lead and Opium Pill, Diluted Sulphuric Acid and Laudanum, or a combination of Diluted Acetic Acid, Lead Acetate and Morphine Acetate. In certain cases these remedies may be administered in enema, an enema containing Laudanum being particularly valuable. Bismuth answers well in delicate subjects, as the Carbonate or the Oxy-nitrate, combined at first with the Salicylate. Nervous diarrhœa may be relieved by Potassium Bromide. Bael Fruit is used empirically. Some forms of chronic diarrhœa, and the flux of uræmia (when it can be checked safely), are best treated with Ferric salts.

Diet must be regarded as of equal importance with medicinal treatment in diarrhœa. In simple acute cases temporary abstinence is the best remedy, and moderate feeding is always advisable: this secures rest to the bowel in all its functions. As a rule the food must be entirely

fluid, and will consist chiefly of either broths or milk according to the cause at work. The former must be carefully prepared, without fat, vegetables or seasoning, and given tepid. Milk must not be in a form which will yield a large indigestible curd—itself a source of intestinal derangements, but given with effervescing alkaline waters or Lime Water, or boiled and mixed with some kind of starch, such as arrowroot or ground rice in the case of adult patients, in infants as special milk mixtures. Eggs must be used with caution. Ice serves occasionally to relieve thirst, or sips of toast-water; draughts of all kinds must be avoided. Stimulants may be required in the aged, in infants, and, indeed, in all cases of protracted diarrhœa, brandy and port being the most suitable forms. Raw meat is useful in chronic cases.

2. *Deficient intestinal action.*—The treatment of simple constipation ought to be preventive; and consists largely in careful regulation of the diet, which should include fruits, green vegetables, meats, and "whole" brown bread, whilst milk and strong tea are to be avoided. As a rule, however, the chronic "habitual" form calls for active interference.

The cause must first be removed, if it can be discovered. The diet, digestion and liver must be regulated; and sufficient muscular exercise, mental relaxation and other hygienic provisions ensured. Actual obstruction demands surgical interference.

Habitual constipation, being generally referable to *torpidity of the muscular coat*, will be rationally treated by means of nervo-muscular stimulants. But these may have to be preceded by a free evacuation, since the tone of the intestinal wall cannot be restored until over-distension has been removed. For this purpose a more powerful purgative must be given at first, such as Colocynth and Blue Pill, followed by a saline, to thoroughly empty the gut. A regular course of aperient medicine may then be commenced. There is considerable choice of drugs which increase peristalsis, the best for habitual use being Aloes, Senna and Cascara Sagrada. Nux vomica (Strychnine) is often added, in cases where the muscular tone is deficient or has been lost by protracted over-distention; and Belladonna is a valuable adjuvant of Aloes in particular cases. Rhubarb, which is a popular aperient, is apt to produce further constipation.

Muscular torpidity is also rationally treated with cholagogues; and Rhubarb, Aloes and Podophyllin in small doses act partly in this way. The saline cholagogues, such as Sodium Sulphate, and the many bitter mineral waters now sold (such as Friedrichshall and Hunyadi János), are highly

popular habitual purgatives, but are apt to lose their effect if given for a length of time, and then to increase rather than relieve constipation. In anæmic subjects the Pilula Aloes et Ferri, and in uterine inactivity the Pilula Aloes et Myrrhæ, are specially indicated. Purgative or simple enemata must occasionally be ordered, but the practice must not be continued lest it become habitual. It may be necessary to keep up the action of nervo-muscular intestinal stimulants for an indefinite period; and, to secure success, observance by the patient of a fixed hour for daily defæcation is essential.

Severe and protracted constipation, in which the bowels are heavily loaded with fæces, as in lead-poisoning or spinal paralysis, or as the result of indolent and careless habits, may demand a cathartic. The official preparations of Colocynth are suitable in such cases, containing as they do Aloes and Scammony, so that if they be followed by a saline draught, the entire length of the bowel will be evacuated. Sometimes even Croton Oil is required. Purgative enemata may be preferable to repeated purgation by the mouth in weak subjects.

3. *Other uses of purgatives.*—The treatment of constipation constitutes but a small part of the use of purgatives. In a considerable proportion of the cases in which purgation is practised the indication is to hasten or increase the natural activity of the bowels, in order to obtain some or all of the other effects of free evacuation which we have already studied. The practical question then comes to be, which degree of activity of purgation is desirable. The activity of a purgative may be estimated by the rapidity of its effect, by the number of the evacuations, by the amount of water in the stools, and by the degree of constitutional disturbance which it produces; these results, as a rule, varying directly with each other.

When there exists an urgent indication for the *reduction of the general blood-pressure*, for instance in cerebral hæmorrhage with enlarged heart, the most active purgatives are employed. A *drastic* must then be given, such as Croton Oil, which has the further advantage of being very easily administered to an unconscious patient. When the portal system, heart or systemic veins are overloaded, and the fluids of the blood are finding their way out of the vessels so as to constitute dropsy, *hydragogue cathartics and salines* are given, to establish a free flow of water from the bowel and thus relieve the circulation. Jalap in the form of the Compound Powder, Kaladana, Turpethum, Colocynth, and Elaterin, are commonly employed; Scammony less frequently. Saline purgatives, either alone or after a purgative pill, have

the same effect, such as the Sulphates of Sodium and Magnesium, Cream of Tartar, and Rochelle Salt.

At the commencement of inflammatory affections, for instance acute bronchitis or local abscess, it is usual to unload the bowels, and relieve the liver, heart, vascular system and respiration by means of a *simple purgative*. The Colocynth and Hyoscyamus Pill, with or without Calomel or Blue Pill, is well adapted for these cases, being given at night and followed in the morning by a Seidlitz Powder.

Chronic congestion of the pelvic organs, bowels and liver, a form of disorder not uncommon with sedentary persons, especially women, may call for a course of treatment by *aperient mineral waters* (usually containing Sulphates of Sodium and Magnesium) at some watering-place, or systematically at home.

Purgatives must be used with special caution: in delicate subjects, such as infants and the aged; in persons weakened by disease; in inflamed, ulcerated and obstructed conditions of the bowels; when there is a tendency to hæmorrhoids and other affections of the rectum; in pregnancy, and during menstruation. In such subjects and conditions, constipation should be relieved if possible by enemata or mild aperients, such as Castor Oil, Sulphur, Senna, and dietetic laxatives. Aged persons do not bear saline purgatives well unless they be given warm or combined with a carminative. The evil effects of the habitual use of strong purgatives have been already referred to.

Anthelmintics.—In connection with the remedies directed to the intestine must be discussed the *anthelmintics* (ἀντὶ, against, and ἕλμινς, a worm) or medicines which expel or kill worms. These belong to two classes, namely, (1) **vermifuges**, which simply expel the parasites (*vermis*, a worm, *fugo*, I drive out); and (2) **vermicides**, which destroy them (*vermis*, a worm, and *cædo*, I kill). The vermifuges belong to the cathartic purgatives, such as Scammony and Jalap: they may be given either alone, or combined with (or several hours after) a dose of a vermicide. The principal vermicides are Male-Fern, Turpentine, Kousso, Embelia, Melon, Pumpkin Seeds, Pomegranate Root Bark and Santonin. The last two drugs act specially on the ascaris, the others kill the tape-worm. The thread-worm (oxyuris) which infests the rectum is best reached by anthelmintic enemata of Turpentine, Aloes, or Salt and water, preceded by injections of a bitter infusion, such as Calumba, Andrographis, or Quassia, with or without iron, to remove the mucus in which they live.

CHAPTER VII.

THE LIVER.

I. PHYSIOLOGICAL RELATIONS.

THE substances which enter the liver through the portal vein consist of the products of digestion in the widest sense, namely, proteids, glucose, salts, a trace of fat and abundant water. When we parted with the proteids in the duodenum they were in the form of peptones and products of their decomposition; when we meet with them again in the vena portæ they have been transformed into ordinary albumen and globulin in the process of absorption. The proteids, glucose, water, salts, etc., will obviously be poured into the liver very abundantly during digestion. At the same time there enters the liver through the hepatic artery a supply of oxygen which appears to be precariously limited, if we may judge by the size of the vessel. In the presence of this double supply, and in proportion to it, the hepatic cells display their special activity, and yield glycogen, urea and bile. The urea and bile are carried off as such, the former by the hepatic veins to escape by the kidneys, the latter by the bile-ducts, the peristalsis of which and of the gall-bladder, evoked by the presence of chyme in the duodenum, conveys it into the bowel. The glycogen has a less simple history. It accumulates in the liver cells, where it appears as a form of amyloid material specially adapted for storing up in an insoluble state the sugar and part of the proteids. By this arrangement the blood and body generally are saved from being flushed with sugar after each meal, and the sugar itself is not wasted. Under the influence of a ferment the glycogen is gradually transformed—mainly into some kind of sugar, partly into fat and proteid; the amount of amyloid material hydrated varying with the necessities of the system. This function is regulated by a nervous mechanism, having its centre in the medulla, and the vagus and sympathetic as its efferent and (presumably) afferent nerves.

Another point in connection with the liver to be carefully noted by the therapeutist is *the circulation of the bile.* The bile, having entered the bowel and mixed with the chyme, is

not entirely evacuated by the fæces. On the contrary, much of the products of its most important constituents, the biliary salts, is re-absorbed from the bowel and carried back to the liver, there to be synthesised again into cholates which are once more secreted and discharged into the bowel. Thus the bile may be said to move in a circle, comprised by the bile ducts and gall bladder, the intestine, and the portal vein.

II. PHARMACODYNAMICS.

Although the liver is apparently so inaccessible, we have great control over the influences under which its multiform activity is displayed.

1. By means of the *food* we can completely interrupt the hepatic functions, or interfere with them at our pleasure. The amount of urea, the secretion of bile, the proportion of store glycogen in the liver, may be modified directly, within certain limits, by the amount of food allowed; and the bile, urea and glycogen respectively may be made to vary with the relative proportion of nitrogenous and amylaceous constituents in the diet. The supply of oxygen that reaches the liver by means of bodily exercise is equally under our control. The larger the volume of oxygen entering the liver, the more ready and complete will be the subtle processes of chemical composition and decomposition within it. We thus come to appreciate a fact of the first importance—that we can influence the liver through the medium of its *supply*. But we can do so in another way. We can tap, as it were, the channel of supply, the portal vein. The radicles of the portal vein in the rectum (superior hæmorrhoidal) anastomose with the veins around the anus; and leeches applied to this part will drain blood from the portal system, and thus indirectly from the liver. Closely allied to bleeding in principle is hydragogue purgation, which diverts a quantity of water from the portal radicles in the intestinal wall, and secures its evacuation.

2. The liver may be influenced through its *products* by securing the proper disposal of the urea, bile and glycogen. In the bodily organs, as in the practical arts, rate of manufacture cannot be maintained unless the products be removed. We have seen, in the stomach, that digestion is arrested by accumulation of peptones amongst the food. In the like manner, an accumulation of urea, of bile or of glycogen in the system, interferes with the hepatic processes. Now, as we shall see afterwards, we can increase the elimination of urea by muscular exercise, and by acting on the kidneys, and

thus indirectly stimulate the liver. On the same principle, the disposal of the bile furnishes us with a means of rousing the hepatic functions. This brings us to consider the action of indirect cholagogues.

That portion of the circulation of the bile which occurs in the intestine is thoroughly under our control. We can sweep the bowel empty of its contents ; and with these the bile salts, which otherwise would have been re-absorbed, are expelled from the body. The portal blood and liver are thus deprived of material in which the elements of the biliary salts exist ready made ; and the hepatic cells are driven to secrete afresh. Purgatives which sweep away old bile, and so lead to the production of new bile, are called **indirect cholagogues.** Mercurials specially act upon the liver in this way ; part of their effect appears due to the increased peristalsis of the bile ducts and gall bladder associated with duodenal stimulation.

3. We believe that we can modify the metabolic processes in the liver by **specific hepatic stimulants and depressants,** irrespective of both the supply and the products. Thus, Phosphorus, Antimony and Arsenic influence the metabolic activity of the liver, causing a greater production of urea, and the last two a free flow of bile. Sodium Bicarbonate and Diluted Nitro-hydrochloric Acid have probably a similar effect as regards glycogen and bile. Ammonium Chloride remarkably increases the amount of urea, apparently by its own decomposition, but still probably through the agency of the liver cells. Iron increases the amount of urea. Amyl Nitrite stimulates the glycogenic function, and Phloridzin (not official) produces intense diabetes—but not by acting on the liver only. On the other hand, there can be no question but that the whole process of hepatic activity may be remarkably reduced by means of Opium, and to a less degree by Quinine and Alcohol.

The direct effect of certain drugs upon the secretion of bile is unmistakable. Podophyllin, Rhubarb, Aloes, Colocynth, Colchicum, Jalap, Scammony, Ipecacuanha, Sodium Sulphate, Sodium Phosphate, Sodium Salicylate, and Ammonium Chloride, Diluted Nitro-hydrochloric Acid, and Euonymus and (not official) Iridin, stimulate the liver substance and increase the amount of bile secreted ; they are **direct cholagogues.** Mercurials, including Calomel, as well as acids and such substances as Guaiacum and Sarsaparilla, possibly act less powerfully as direct hepatic stimulants. Opium and Morphine reduce the activity of the secretion.

III. Pathological Relations.

The therapeutics of the liver will be best illustrated by a study of the treatment of its functional disorders. The common causes of derangement of the liver are to be found in the materials supplied to it, namely, food and air, and especially in want of due proportion between the two. Most frequently there is excess of food—excess of rich food, especially of meat and alcoholic drinks, causing also gastric and duodenal indigestion. On the other hand, there may be imperfect oxygenation of the blood supplied through the hepatic artery, *i.e.* deficient respiration and circulation, generally referable to sedentary or luxurious habits, abstinence from muscular exercise, and confinement to ill-ventilated hot atmospheres. Not uncommonly the two classes of causes are combined, as is well seen in the disorders and diseases of the liver so common in the tropics. Mechanical congestion and derangement of the liver are one of the effects of cardiac dilatation with failure in valvular disease.

Another way in which disorders of the liver originate is through retention of the products. If the kidneys, lungs or bowels are inactive, or if the ampulla of Vater be obstructed by duodenal catarrh, the liver will be blocked, as it were, with urea, uric acid, sugar and bile; and hepatic metabolism will become feeble. This condition is generally referable to impaired muscular and circulatory activity; to want of exercise, air and light, which begets renal and intestinal torpidity, and to large or otherwise improper eating: it is a disorder of town life. In other cases debility of the liver is distinctly inherited.

In whatever way induced, derangement of the liver consists in certain disturbances of the chemical processes within it, which manifest themselves by altered composition of the excretions and many well-marked symptoms. The urine contains an excess (rarely a deficiency) of urea, an excess of uric acid, occasionally sugar, and even albuminous bodies, derived probably from the liver; whilst its reaction is disturbed, the colouring matter is in excess, and leucin and tyrosin may make their appearance in it. The bile is altered in quantity and quality, giving rise to diarrhœa or constipation with foul pale stools, catarrh of the ducts and gall bladder, and formation of gall stones. The general symptoms of biliary disorder are referable to the circulation in the blood of an excessive amount of the normal products—urea, uric acid, etc., and of imperfectly formed products allied to these.

Such products of disordered metabolism, though differing from the normal only by a few atoms, or in the arrangement of their atoms, may be highly deleterious in their action on the body. Entering the blood by the hepatic veins, they disturb the nervous system, and are the cause of the sleepiness, languor, irritability of temper, the headache, and the general misery and melancholy so familiar in the "bilious." They enter the muscles and produce aching, weariness, muscular debility and trembling. Palpitation and flushing indicate their action on the circulation, whilst the general nutrition also suffers. If this condition persist, certain chronic states of the system are induced, which are known as gout and lithæmia. The heart and vessels become diseased, as well as the skin and joints. Continued disturbance of the reaction and constitution of the urine leads to solid deposits in the urinary passages, constituting gravel or calculus; and structural disease of the kidneys may ultimately result. Alcoholism often ends in chronic interstitial hepatitis, commonly known as cirrhosis of the liver.

Absorption of bile into the lymph and blood may occur in these cases, but more so in actual obstruction of the ducts, which leads to *jaundice*. In either case, some or all of the constituents of the bile enter the blood, circulate with it, colour all the organs, and are cast out in the various secretions, especially the urine.

Lastly, glycogenesis may be disordered, and sugar make its appearance in the blood, urine, and all the tissues, constituting glycosuria or diabetes mellitus. Excess of sugar-yielding food may cause this, as we have seen, but well-marked diabetes is generally referable to derangement of the elaborate nervous and chemical processes of storing, redistributing and assimilating the nutrient elements of the food carried on in the liver and tissues. Hunger, weakness, and wasting are therefore its prominent symptoms, and thirst is also very urgent from the diuretic effect of the sugar. In some instances diabetes has been traced to injury or disease of the hepatic ("diabetic") centre in the brain, or of the nervous connections between it and the liver.

IV. Natural Recovery.

Disorder of the liver disappears in favourable circumstances; that is, with the return of normal influences. Recovery is assisted, on the one hand, by temporary abstinence from food, brought about by loss of appetite, or even loathing for food; and, on the other hand, by excretion of

the morbid products. Excess of bile relieves itself naturally by bilious diarrhœa. Nature requires guidance, however, in hepatic disorders, for the languor, depression, and muscular debility which it originates tend to give rise to further indisposition to exercise, and thus to an aggravation of the evil.

If continued indulgence in alcohol induce hepatic congestion, the resulting portal fulness may be relieved by fluxes from the intestinal mucosa, occasionally hæmorrhagic, or by actual hæmorrhages from the stomach and bowels. Under the same influences, repair by fibrosis unfortunately ends in further portal obstruction, but this is spontaneously reduced by the opening out of different anatomoses between the portal and the systemic systems.

V. THERAPEUTICS.

1. Hepatic disorder can be *prevented* only by taking a comprehensive view of the relation of the liver to the organs of digestion, absorption, blood formation and excretion. The income, in the form of food and air, must be thoroughly supervised. The diet must be definitely ordered: proteid foods as stimulants of the bile, fats in relative excess where functional rest is called for. Perfect digestion and intestinal activity must be secured. In many cases it is found that when this has been done, little more is required. Abundant bodily exercise must be recommended. The atmosphere breathed must be as pure, cool and bright as possible. Sedentary or lazy habits must be changed for wholesome exercise in the open air, in the form of walking, riding or games. In the class of cases of disordered liver constantly met with in large towns, change is essential from the foul, hot, dull atmosphere of the workshop and dwelling to the pure air of the parks or of the country. But the beneficial effect of exercise on the liver is not to be estimated solely by the amount of oxygen admitted. It will also be evident in increased activity of the kidneys, skin and bowels, all of which will unburden the liver by hastening the removal from the blood of metabolic products.

2. If prophylaxis fail, and disorder be actually present, *remedial treatment* must be undertaken. The first step will be to remove, if possible, the causes of the disorder. Errors in the mode of living must be reformed. Active medicinal treatment is begun at the same time. A brisk purge must first be employed, to sweep the intestine of imperfectly digested food, and stimulate its absorptive, excretory and locomotive functions. The question of the selection of a

purgative introduces us to the use of cholagogues, direct and indirect. Calomel and Colocynth, Rhubarb and Colocynth, Podophyllin, and other purgatives and cholagogues, mentioned in the second section, in proper combination with carminatives, are in constant employment for increasing the flow of bile. An almost invariable practice is to follow up the purgative by a saline, and the rationale of this plan is obvious. The Sulphate of Magnesium, Sulphate and Phosphate of Sodium (in various combinations, including the Effervescing forms and the Seidlitz Powder), not only complete the evacuation and stimulation of the bowel and the cholagogue effect, but their hydragogue influence (with that of the previous purgative) will drain a certain amount of water from the portal vein, and thus relieve the hepatic circulation as well as possible hæmorrhoids. Further, some of the salts will enter the blood, and be excreted by the kidneys, which they stimulate, thus opening a second channel of relief to the liver, the urinary discharge. The tartrates pass out in the urine as alkaline carbonates, and by this means the excess of uric acid, which may have threatened or had actually produced gravel, is neutralised and safely conducted from the body. Altogether the time-honoured Blue Pill and Seidlitz Powder form a combination which is in every respect scientifically sound, although probably of purely empirical origin. In urgent cases of acute hepatic disorder, the therapeutist might even divert part of the blood supply by tapping the portal vein, that is, by applying leeches round the anus.

An attempt may next be made to act upon the liver *directly:* to rouse its metabolic energy by one of the specific agents already enumerated. Perhaps the best of these in acute hepatic disorder is Sodium Bicarbonate, given between meals in some of the combinations suggested in Chapter III., especially with Rhubarb, Senna, Aloes or Sodium Salicylate. In more chronic cases, Ammonium Chloride or Arsenic often proves of great service, given immediately after meals, or that valuable combination of hepatic stimulants, the Pilula Hydrargyri Subchloridi Composita, given every night for a week on end. In cases of chronic hepatic disorder originating in the tropics, Diluted Nitrohydrochloric Acid is often used with success both internally and as a bath. The effects of hepatic disorder upon other parts of the system frequently demand direct relief, such as the headache, languor or mental depression. Alcohol sometimes answers the immediate purpose, but it induces further hepatic disorders, and is otherwise objectionable. Like remarks apply to Opium, except in very small doses "to take the edge off the misery."

Quinine given after meals is of unquestionable service in many instances. Tea and coffee are useful and safe remedies. But on the whole too much reliance must not be placed on attention to symptoms. Some of the natural Mineral Waters are valuable in chronic disorders of the liver, particularly Carlsbad, Vichy and Harrogate.

For the treatment of that remarkable disorder of hepatic metabolism which is called diabetes mellitus the complete rearrangement of the diet is the first requisite, by the removal of amyloid and saccharine substances from the food. Nothing in the whole range of therapeutics is more striking in its way than the effect of Opium, Morphine or Codeine in dispelling the last trace of sugar from the urine in many of these cases, the quantity of the drug tolerated being sometimes enormous.

CHAPTER VIII.

THE BLOOD.

We shall suppose now that the products of absorption and hepatic metabolism have entered the blood. The peculiar relation which the blood bears to the solid organs gives a special character to its pathology and therapeutics. It is a great fluid medium which conveys nutrient material and oxygen to the tissues, and carries away the soluble products of their activity. In the same way it is the medium by which the active principles of drugs reach the internal organs without, as a rule, materially disturbing the functions of the blood itself. It is not surprising that the blood, besides presenting morbid conditions peculiar to itself, is liable to suffer in consequence of disorder or disease of the digestive and assimilative organs from which we have traced its supply, and of the excreting organs by which its constituents finally leave the body, as well as of the circulatory and respiratory organs and the viscera in general.

I. Physiological Relations.

The physiological relations of the *liquor sanguinis* or plasma are very obvious: it is the medium of nutrition. It carries between the different organs the materials which are the *sources* of energy, namely, proteids, fats, sugar, water and salts, as well as the *products* of the vital processes—carbonic acid, water, urea, uric acid, salts and other substances. It possesses a mean volume, an alkaline reaction depending on the presence chiefly of salts of sodium, and a certain general uniformity of composition, which, however, varies considerably at different parts of the circulation—for instance, before and after exposure of the blood to the liver, lungs, muscles or other active organs. The composition of the liquor sanguinis is indeed the balance of two opposed processes—a process of supply, income or ingestion, which we have traced through the liver from the food; and a process of output, expenditure or egestion, carried on by the active organs of the body, with their measurable products—energy and the excretions.

The *white corpuscles* are physiologically associated with

the plasma, that is, are essentially nutritive, in function. Some of them are amœboid and phagocytic.

The function of the *red corpuscles* is distinct from the functions of the plasma. They are the great medium of internal respiration, carrying oxygen from the lungs to the tissues, and are thus the respiratory elements of the body. It is important for the therapeutist to remember that the red corpuscles consist chiefly of *hæmoglobin*, with a small quantity of salts, which have *potassium* as their principal base associated with *phosphoric acid*. *Iron* is an essential component of hæmoglobin, the respiratory pigment. Whatever may be the immediate source of the red corpuscles, there can be no doubt that the most important factors in their development are food, air, and free exposure of the blood to light. Ultimately they are broken up, their products forming the colouring matters of the various secretions.

II. PHARMACODYNAMICS.

1. Our power over the blood *plasma* in health is easily appreciated. The most obvious means of influencing it is through the *income* or supply. We can alter a man's diet, his digestion, and his hepatic functions, and by these indirect means we retain a hold on the blood. We can also modify its several constituents during their ingestion—the proteids, sugar, water, phosphates, carbonates, chlorides, sulphates, etc.—by regulating the food, or administering them in the form of drugs. A fact of great therapeutical importance is that we can *increase, within certain limits, the alkalinity* of the plasma by means of alkalis or alkaline earths, given as the Bicarbonates of Potassium or Sodium, as the various Solutions of these, or as Lithium, Calcium and Magnesium salts ; or in a more moderate degree over a longer period, by means of the many natural alkaline waters, such as those of Vichy, Carlsbad, Baden-Baden, Ems and Bilin. **Alkalinisers of the blood** not only act upon the plasma directly, but have been believed to do so indirectly also, by combining with urates, and carrying them with them out of the system by virtue of their diuretic influence, though this is now denied. Potassium is the most rapid and evanescent alkaliniser ; Sodium is slower and more permanent, as is fully described at page 45. The citrates and tartrates are also true alkalinisers of the blood, being decomposed, as we shall presently see, in the presence of the red corpuscles, into alkaline carbonates. It is much more difficult to *reduce the natural alkalinity* of the blood. Mineral Acids have very little effect

in this direction, as they enter the blood in the form of neutral salts of potassium, sodium, etc., which pass out undecomposed. Citric and Tartaric Acids do remain partly unchanged in the plasma; and Benzoic, Cinnamic and Salicylic Acids also pass through it, the two first being partly converted into hippuric acid. Free iodine may be temporarily liberated in the plasma from the iodides.

Besides these, most of the drugs in the materia medica enter the system through the plasma, where they exist in every possible form, whether unchanged, or as albuminates, chlorides, sulphates, etc., or as highly complex compounds. It is most important, however, for the student to observe that, beyond the alkalis and acids, but few drugs act upon the plasma. The great majority of them simply exist in it, and are conveyed by it to the tissues and organs of elimination, where they exert their specific influences.

But we may go beyond this, and alter the total amount of blood or plasma in the body by actually adding to it from the blood of another person or animal. This is done by *transfusion*, a powerful means of restoring the blood, but one which is not free from danger nor always available. Subcutaneous injection of normal saline solution is at once a safer and equally useful method.

2. We can affect the value of the plasma through the *expenditure* or egesta. We have seen that purgation is a ready means of influencing the water, salts, albumen and other constituents of the plasma in the portal system, and thus in the blood generally. We shall find in subsequent chapters that in the same way we can stimulate excretion by the kidneys and by the skin. We shall also discover, under the head of metabolism, that we can so far either tax or spare the great organs which are the sources of vital energy and therefore of waste, such as the muscles, and thus the metabolic and nutritive value of the whole blood. But we can go much farther than this: we can actually *abstract* a certain quantity of blood by venesection, cupping or leeching, as we have already seen in the case of the portal vein. Such alteration in quantity will cause a decided alteration in quality, for, as we shall find in Chapter X., abstraction of blood is followed by absorption, and thus increases the amount of water in the plasma.

3. Some drugs act directly upon the *white corpuscles*. Quinine reduces their number and paralyses their movements; Veratrine kills them (out of the body). All aromatic oils, resins and gum-resins, especially Myrrh, increase the production of them by stimulating intestinal absorption.

4. We can increase the richness of the blood in *red corpuscles*, and the richness of the individual corpuscles in hæmoglobin, by giving abundant digestible and assimilable food, and by securing the activity of the alimentary tract. Fresh air and sunlight can be secured by change of habits or residence. We can also increase the constituents of the red corpuscles admitted into the system. Iron, which the Pharmacopœia provides in so many forms, increases the hæmoglobin even in healthy individuals, whether directly or not. Potassium Sulphate, in proper combination with iron, as in the Mistura Ferri Composita, unquestionably increases its value. Phosphoric Acid, whether as the Diluted Acid or as the Iron Phosphate and other bases, is also a reputed blood restorer. All these substances, and such others as indirectly improve the quantity and quality of the hæmoglobin, are known as **hæmatinics**.

Arsenic, Phosphorus and perhaps other metals combine with the hæmoglobin, partially reduce it, or otherwise interfere with its constitution or quantity so as to impair the oxygenating power of the corpuscles, if given in full doses. Citrates and Tartrates have a peculiar deoxidising effect on the blood, being converted in part into carbonates at the expense of the hæmoglobin, thus, $2[C_3H_4{\cdot}OH{\cdot}(COOK)_3] + O_{18}$ (from hæmoglobin) $= 3K_2CO_3 + 9CO_2 + 5H_2O$. Lead reduces the number of the red corpuscles, but probably indirectly—by interfering with digestion. Iodine and Sulphur (Sulphides), Turpentine and a few other drugs, such as Diluted Hydrocyanic Acid, reduce the oxyhæmoglobin of the corpuscles, but only after excessive doses, so that in this respect they may be regarded, not as drugs, but as poisons, and will be noticed in the next section. The Nitrites of Amyl and Sodium and Spiritus Ætheris Nitrosi convert part of the hæmoglobin into methæmoglobin, but only when given in excess. On the other hand, Alcohol and Quinine bind the oxygen more firmly to the corpuscles, and thus reduce oxygenation. Nitrous Oxide gas acts indirectly on the corpuscles by taking the place of oxygen, but does not chemically combine with the hæmoglobin. It is manifest that the methods of venesection and transfusion will influence the corpuscles as well as the plasma.

III. PATHOLOGICAL RELATIONS.

As we mentioned in the introduction, many of the morbid conditions of the *plasma* are secondary; that is, caused by disorder either of the organs from which it draws its supply

—the digestive organs and liver, or of those by which its products leave the body, especially the lungs and kidneys.

Thus excess of blood, which constitutes one kind of plethora, is referable to indulgence in food, combined with indolent habits. The opposite condition, anæmia or deficiency of blood, is a very common disorder, which may arise from an endless variety of causes, whether of the nature of want—insufficient food or imperfect digestion, or of waste—excessive work, growth, exhausting diseases or hæmorrhage. The constituents of the plasma are no doubt often disordered, but this subject is still obscure. The albumens are deficient in anæmia. Carbonic acid accumulates in respiratory difficulty. The water of the blood is increased in anæmia; greatly diminished in cholera, where its excretion is excessive. The alkalinity of the plasma is believed to be reduced in rheumatism, from some unknown cause. Urates are either excessive or in unstable combination in gout. In calculous subjects there is apparently some tendency to disturbance of the blood and of the reaction of the urine, referable to derangement of primary and secondary digestion. Sugar is in excess in diabetes mellitus, probably from disordered supply; urea is in excess in Bright's disease, from defective excretion. The different forms of *white cells* are liable to abnormal increase, as in leukæmia. Pathogenetic microbes and other parasitic organisms may be found in the plasma.

The diseases of the *red corpuscles* are still imperfectly known. They are the principal habitat of the malarial and other parasites. They are morbidly altered in pernicious anæmia. *Deficiency* of hæmoglobin, whether traceable to want of blood as a whole, to poverty of the blood in red corpuscles, or to deficiency of the individual corpuscles in hæmoglobin, reduces its oxygenating value. All the bodily functions become feeble: the patient is weak, dull and sleepy, and suffers from every possible functional derangement, especially shortness of breath.

Reduction of hæmoglobin, or, more correctly, of oxyhæmoglobin, is a result of the admission to the blood, in poisonous quantities, of certain substances which we have already mentioned, such as Phosphorus, Arsenic, or Turpentine in poisonous doses. Carbonic Oxide enters into combination with the hæmoglobin, whilst the oxygen is expelled from the corpuscles. Hydrocyanic Acid unites partly with oxyhæmoglobin, partly with reduced hæmoglobin. Other bodies, such as Sulphuretted Hydrogen, seize upon and combine with the oxygen, leaving the reduced hæmoglobin to be dissolved out of the corpuscles and diffused through the blood. Either of

these conditions is highly dangerous, the new hæmoglobin compound in the first case being with difficulty replaced by oxyhæmoglobin; whilst the reduction and solution in the second case are incompatible with life if they have occurred to any extent.

IV. NATURAL PREVENTION AND RECOVERY.

After disturbance by disease, the composition, functional value and quantity of the liquor sanguinis readily return to the normal. In other words, "the blood has high powers of self-adjustment to a normal standard." The same is true of the corpuscles. As long as the disorders of the red corpuscles are of a purely quantitative kind, restoration of normal conditions is followed by return of the blood-elements to their proper constitution. One natural means of recovery is to be found in the shortness of breath which accompanies anæmia, and which increases the intake of oxygen, and compels the patient to rest and thus spare the blood the common sources of waste. At the same time the increased frequency of the breathing and pulse compensates for want of hæmoglobin. Unfortunately there are limits to recovery, as when large quantities of a poison, such as carbonic acid, have entered the blood, or when the hæmoglobin has been "reduced."

The *liquor sanguinis* also contains or can develop bacteriolysins, hæmolysins, antitoxins, agglutinins and precipitins, chemical or bio-chemical substances which constitute provisions of different orders for protecting the blood and tissues against the germs and toxins of disease, or of counteracting or destroying them.

Some of the white cells are phagocytic. They attack, destroy and remove any germs of disease that may have entered the circulation, and thus promote both prevention and recovery in the blood itself as well as repair of the tissues.

V. THERAPEUTICS.

The facts which we have reviewed under the four preceding heads are highly encouraging to the practical therapeutist.

In *plethora* he will reduce the amount of food, increase the excretions, and prescribe more bodily exercise; fifty years ago he would have bled the patient freely, and repeated the operation at regular intervals.

Anæmia must be treated by the opposite class of measures, which will be discussed immediately under the head of the red corpuscles. Speaking generally, we must insure oral

sepsis, restore and sustain the appetite and digestion, spare the body every possible exertion, maintain healthy excretion, and, if the condition be urgent, transfuse blood, or inject normal saline solution into a vein or subcutaneously. Deficiency of albumen is met by the same measures. Excess of carbonic acid demands artificial respiration.

When the indication is to *increase the alkalinity* of the plasma in rheumatism, gout and allied morbid states, we administer salts of Potassium, Sodium, Ammonium, Lithium, or the Alkaline Earths, the Alkaline Citrates and Tartrates being the most suitable because large quantities can be admitted into the blood without deranging digestion. Acids, which have so little influence in the opposite direction, are fortunately seldom called for. The treatment of poisons in the blood, whether formed in the body or introduced from without, will rationally consist first in removing their cause, *e.g.* indigestion or renal disorder, or in decomposing or neutralising them chemically. This introduces us to the second use of alkalis in the blood. The acid of rheumatism, whatever it may be, and the excessive or loosely combined urates of gout, are converted into soluble salts by some of the Alkalis and Alkaline Earths, and these salts are fortunately diuretic. In this way excess of acid is not only neutralised, but conveyed out of the system, and the reaction of the urine may be used as a test of the success of our action on the blood. This end is secured in acute cases by the free exhibition of the milder salts of Potassium and Lithium; in chronic cases by treatment at an alkaline bath, such as Ems, Homburg, Vichy, Carlsbad or Bath. Metallic poisons, such as lead, are removed from the blood and tissues in a precisely similar way; lead, for example, by Potassium Iodide or Sulphur baths. Poisons also may be removed from the blood by simple increase of the excretions—carbonic acid through the lungs by artificial respiration; urea by diuresis, free purgation and diaphoresis; and so with the products of indigestion, which is relieved by purgatives. Micro-organisms and toxins are combated with anti-toxins.

If the *hæmoglobin be deficient*, we must secure a sufficient supply of digestible and nutritious food, pure air and direct sunlight; reduce the amount of work, by ordering rest or even temporarily confining the patient to bed; and attend to all the functions which are connected with the formation, growth and purification of the blood. Correction of derangements of the stomach and bowels always demands special attention, and is a *sine quâ non* of success. At the same time, any actual waste of the blood must be arrested, if

possible. Passive hæmorrhages must be checked. Growth and development may be rendered less trying by directing the blood to parts where it is specially required; for instance, to the uterus by means of emmenagogues. We must next hasten to restore the red corpuscles by supplying their important chemical elements—Iron, Phosphoric Acid and Potassium. Long before the composition of hæmoglobin was understood, it had been empirically discovered that Iron was a certain remedy for "want of blood." This is our daily experience still; science in this instance has confirmed and rationalised, not suggested practice. Iron has other actions and uses therapeutically, but its chief employment is as a hæmatinic. The particular form in which the metal may be administered is discussed under its own head, but one or two combinations of iron must be noticed here. The Mistura Ferri Composita (an old-established empirical combination of Ferrous Sulphate, Potassium Carbonate, Myrrh and Aromatics), and the Pilula Aloes et Ferri are specially successful remedies in anæmia, the rationale of which will now be obvious to the student. In many instances great benefit is derived from chalybeate waters, such as those of Spa. Altogether, the medicinal treatment of deficiency of hæmoglobin practically resolves itself into the continuous administration of iron, without impairing digestion or the action of the bowels. The malarial parasite yields to quinine.

In urgent cases of want of blood corpuscles, whether acutely developed by hæmorrhage or progressing slowly to an extreme degree, transfusion of normal saline is practised. The treatment of hæmorrhage is discussed at page 552.

Reduction of oxyhæmoglobin defies therapeutical measures if it have advanced beyond the very first stage: that is, the treatment of poisoning by carbonic oxide, prussic acid, etc., is rarely successful. It must, however, be attempted. Combined venesection and transfusion would theoretically be the proper treatment—to remove disorganised blood and poison, and to replace them by healthy corpuscles and plasma. But manifestly this is very rarely practicable. All that can be done, as a rule, is to sustain the circulation and respiration, by general stimulants and artificial respiration, and thus preserve vitality by means of the oxygen and hæmoglobin that may still remain active. In every case it will be proper to do this until transfusion of saline can be undertaken.

CHAPTER IX.

METABOLISM—THE SPECIFIC ACTIONS OF MEDICINES.

WE now pass on to consider the process of metabolism, that is, the intra-molecular changes that occur in living tissues during the development of force by them in the presence of the blood. We shall find that this subject has an important bearing on the specific actions and the uses of many drugs and other therapeutic measures.

I. PHYSIOLOGICAL RELATIONS.

The best means of comprehending the obscure subject of metabolism is to take the instance of a muscle. A muscle has a definite structure; it enjoys a free supply of nutrient blood from which it assimilates the oxygen and the constituent elements of the plasma; it displays force during the period of its contraction, namely mechanical energy, heat, electrical change, and sound; and its molecular disintegration produces certain chemical substances—carbonic acid, water, sarco'actic acid, creatine, ammonia, and other allied nitrogenous bodies, sugar, and (after an interval) urea. The blood that passes through the muscles becomes venous, that is, it loses oxygen and a small quantity of proteids and other elements of the plasma, and it takes up the waste products.

In doing this work, the muscle first incorporates the oxygen and certain elements of the plasma with its own substance—assimilation—however loose the combination may be. In this respect the molecules of the muscle are being constantly changed. This is a fact of the first importance to the pharmacologist: that when a muscle or other living tissue incorporates metabolic materials, and forms force and other products from them, its own molecules are changed or altered. If the composition of the plasma supplied to it be modified, the materials assimilated by the muscle naturally will be different; also the amount and character of its force and chemical products; and not only these but the chemical (possibly even the anatomical) constitution of the active protoplasm. In short, we may say that muscle and plasma act and react upon each other: that the protoplasm *acts on* or *alters* the plasma; that the plasma *acts on* or *alters* the protoplasm.

This process of double decomposition appears to be going on in every organ and tissue of the body; though, naturally,

the tissue being different in each case, so are the particular substances broken up by it, the products yielded by it, and the particular kind of force which it displays—for instance, secretion, nervous energy, growth and development. At the same time the heat that is developed is distributed and lost; the carbonic acid, the water, and the nitrogenous and other bye-products are excreted by the lungs, skin, kidneys and bowels after further decomposition and recomposition of the nitrogenous waste in the liver, where the chief final product of proteid metabolism, urea, is partly, if not mainly, formed; and the active organs are maintained in size and vigour amidst the continual change.

There are various *means of estimating* the state of metabolism in the living body. We may measure, first, the amount of *force displayed*—the muscular activity or tone, the rate of growth, the temperature, the mental capacity; or, secondly, the amount and kind of *material consumed*—of air inspired, and of food taken—which stimulates tissue activity and thus increases the elimination of oxygen; or, thirdly, the *products* of metabolism, that is, the excretions. The first two means are by no means always available with accuracy. This is what makes the examination of the urine, the principal excretion, so important in the majority of clinical cases; for if we know the state of the urine, we can work backwards, as it were, and estimate the functional activity and even the anatomical state of the organs in which its constituents have been produced.

But metabolism is not the simple process which we have described. In many respects it is still very obscure. Thus the proteids are not at once broken down into carbonic acid, water and nitrogenous compounds, as represented. In some of the tissues at least there are intermediate products, one of which is fat, which is in turn oxydised into carbonic acid and water. Indeed all the tissues and organs are interdependent physiologically, and disturbance of any one of them upsets general metabolism. This truth is well illustrated by the part played by the *internal secretions* of the thyroid and supra-renal glands, as well as of the kidneys, liver and pancreas. It is also possible that all metabolism is associated with intracellular *ferments*, like digestion and the coagulation of the blood; and the action of some of these appears to be reversible. Lastly, the intimate protoplasmic changes which are the basis of vital force are controlled by the nervous system: by *trophic* centres lying in the cerebrum, cord and spinal ganglia, with afferent and efferent trophic fibres, and also in part by the *vaso-motor* system.

II. Pharmacodynamics.

This brings us to the second part of our inquiry—our power over metabolism in a healthy individual. This is greater than would at first appear.

1. Our influence on metabolism through *the blood as a whole* has been fully discussed in the preceding chapter, and does not require to be more than mentioned here.

2. We can affect nutrition through the *constituents* of the blood which supply material to the particular organs. Experience taught us, long before science, how to feed a man in training for muscular exertion; which kinds of food are specially suited for the exercise of the brain, for the periods of growth and development, of pregnancy and lactation, of degeneration and decay. It is but expressing the same fact in other words to say that by supplying an excess of certain kinds of food, we can increase the activity of an organ, the cells of which appear to exercise themselves more vigorously when their natural source of energy and nutrition is freely supplied to them. Alcohol, Cod-liver Oil, and Olive and Almond Oils are thus valuable foods or **nutritive tonics.**

3. An increased supply of *oxygen* in the blood increases metabolism. The valuable influence of fresh air on active organs is familiar, and we have learned in this connection the use of iron, which is thus a **hæmatinic tonic.**

4. An increased amount of work is an interesting means of increasing protoplasmic activity. By throwing more weight upon a muscle, up to a certain point, we can increase the force of its contraction. This is *exercise;* and it accompanies a sufficient supply of plasma and oxygen. A man in training not only selects his food and air, but throws an increased amount of work on his muscles by exercising them regularly.

5. We can influence metabolism by means of the *excretions,* that is, by hastening the removal of its products through the lungs, kidneys, skin and bowels, as we have already seen in the case of the stomach and liver. Thus alkaline diuretics quicken metabolism. The same principle manifestly applies to all the tissues.

6. The intracellular changes as a whole throughout the body are said to be increased by electrical-field effects set up by high tension and high-frequency or sinusoidal currents.

7. The *trophic* centres are amenable to impulses carried in by their afferent fibres; and such of these fibres as originate at the surface of the body are readily accessible, and will convey inwards impulses produced by any influences that we may bring to bear upon them. Such are massage,

extremes of heat and cold by means of the cold bath or douche, the irritant effect of Mustard or Cantharides or Mylabris, and the direct battery current. Mental conditions also affect the trophic centres directly, as well as modifying metabolism through other channels.

The physiological effects of massage are very powerful. Its actions are complex, partly direct as well as reflex through the trophic nerves. Massage causes, first, dilatation of the local vessels, leading to increased circulation in the tissues; more rapid removal of the products of nutrition by the lymphatics and veins; and an actual exercise of the tissue elements, *e.g.* of the muscles, by well-arranged movements. No doubt these effects can be increased by the use of certain local circulatory stimulants, in the form of liniments of Ammonia, Alcohol, Chloroform, and the great group of Volatile Oils of the Turpentine and Camphor series. But, further, massage reacts upon nutrition generally, probably through the nervous system, and greatly stimulates it, improving the appetite and digestion, and increasing the strength and weight of the body. It is thus both a **local tonic** and a **general tonic**. The action of poultices, blisters, some forms of electricity and other local applications on the nutrition of deeper and remote parts, which is known as *counter-irritation*, is to be accounted for partly in this way. It is discussed fully in Chapter XV.

8. The *surrounding temperature* has a powerful effect upon nutrition. Heat and cold are universally recognised as being stimulating, enervating, relaxing, tonic or bracing, as the case may be. Water, in every form, from vapour to solid ice, and electricity are convenient means of bringing any temperature that may be desired into contact with the tissues, whether directly or indirectly through the vessels and nerves. In other words, we possess, and have greatly elaborated, the means of affecting nutrition by climate and baths, the actions and uses of which are the subjects of **climatology** and **balneology**.

9. *Medicines.*—We have made a further important discovery with respect to our influence over metabolism: that when we admit to the organs an excess of the normal constituents of the blood, or other bodies than these, including drugs, they participate in the vital processes and variously modify them. Thus acids increase the formation of ammonia in the tissues generally, and alkalis diminish it. If such a foreign substance as Mercury be introduced into the blood, the muscular and other tissues will take it into their substance, just as they take up proteids, salts of lime,

oxygen, and water, and incorporate it in a loose chemical way, their own proper structure being essentially unaltered. By whatever channel they may be introduced into the blood, most of the active principles of the materia medica are carried in the plasma to the tissues and organs, and are said to "act upon" or to "have a specific action" upon them. Iodine acts upon the glands, Bromine upon the brain, Potassium on the heart, and so on. By this we mean that the medicines, having reached an organ, take part in the process of metabolism; that they become loosely incorporated with the anatomical elements of the part; that they form, either in these, or in the presence of these, certain chemical compounds different from the ordinary; that they are cast out again in the metabolic products, either unchanged or in a new chemical form; and that, *in thus passing through the organ and taking part in its activity, they have modified the force which it displays.* Thus, Alcohol, in passing into muscle, becomes oxydised and converted into carbonic acid and water, and in the process of decomposition increases the force of muscular contraction. Alcohol is accordingly said to act specifically upon muscle. So with all tissues and organs: some incorporate from the blood one substance, some another. Just as the life-processes of the various tissues and organs differ from each other, so will some select or be acted on by some principles, others by other principles. Gland protoplasm is acted upon by Iodine, nervous protoplasm by Bromine, muscle protoplasm by Potassium, red corpuscle protoplasm by Iron, and so on.

Here it is necessary to offer a word of caution. The expression "action" of a medicine is generally used in a much wider sense than that just indicated. When we say that a given therapeutical substance acts upon "an organ," we do not always mean that it acts upon the *protoplasm* of that organ. When we say that alcohol acts upon the skin, flushing it and increasing the heat and perspiration it gives off, we do not imply that alcohol is decomposed by the connective tissue cells of the skin. An organ possesses not only its proper protoplasmic cells but vessels and nerves; and a vast number of the effects of drugs upon organs are due, as we shall see in subsequent chapters, to their action upon the vessels and the nerves that supply these organs. Ultimately, of course, all drugs do act upon protoplasm in some form: on the protoplasm of muscular tissue, of nerve-ganglia, of the walls of blood-vessels, or of the cells of the nerve-centres which regulate the vessels. But for practical purposes it is highly important to keep the actions of drugs upon the

protoplasm of an organ quite distinct from their actions upon the organ through its nerves or its blood supply.

"*Alteratives.*"—The subject of metabolism introduces us to a term that has been applied to certain drugs, namely, **alteratives.** This word, like many other terms in therapeutics, never had an exact application, and therefore defies correct definition. It is therefore objectionable, but its meaning may be discussed if the term itself cannot be defined. We have seen that we can increase the amount of work done by an organ in several ways, through food, air, local excitation, etc., which make it build up and break down more actively both its pabulum, the lymph, and its own proper elements: which, in one word, *exercise* it. Certain medicinal substances also are found to **increase metabolism,** the chief of which are Mercury and Iodine, Phosphorus, Antimony, Arsenic, Salicylates, Sulphides, Benzoic and Salicylic Acids, Thyroid substance and certain doubtful vegetable agents, such as Sarsa and Guaiacum. The particular way in which each of these drugs increases tissue waste is given under its own head, as far as it is known. It naturally occurs to us, that the actions of these medicines are other forms of exercise of the tissues. When Mercury and Iodine, for example, have entered into combination with living protoplasm, and been again disengaged or thrown out of combination with it in the metabolic products, they have *made it do a certain amount of work;* they have hastened its nutrition, and to a corresponding extent they have effected a renewal and a change of its proper molecules: their action might be said to be *alterative.* We find that an essential condition of the success of such drugs, just as it is of physical exercise, is a free supply of the normal sources of metabolism, food and air, in order that the constructive part may keep pace with the destructive part of metabolism. If food and air fail, the health rapidly breaks down, the body wastes, and death may result. Possessing a powerful and peculiar action like this, these medicinal agents fully deserve special recognition, and any method of treatment which may be founded upon their action is incomplete unless it include abundant feeding and fresh air.

Opposed to these measures is an important class of drugs which **diminish metabolism.** Alcohol has this action, apparently by being itself so readily oxydised in the tissues that it robs the cells, as it were, of oxygen, whilst it also binds the oxygen more firmly to the red corpuscles. Again, we know that Opium and Oils diminish nitrogenous waste. Quinine also lowers oxygenation, and has a further

influence in preventing oxydation of protoplasm, which is imperfectly understood. Probably Alcohol, Quinine, Phenazone, Acetanilide and Salicin also diminish the activity of the natural metabolic ferments.

Complex Measures.—Some of the most powerful means at our disposal for influencing nutrition are a combination of the preceding measures. The best illustration of this is the treatment carried on at a foreign bath, we shall say at Aix-les-Bains, in Savoy. Here an English patient enters a new, a purer, and a warmer atmosphere. His food is reduced in quantity and changed in quality; he has to take active muscular exercise; he enjoys a daily bath, which is really a complex arrangement of washing, rubbing, douching and frequent change of surface temperature; and he has to drink a definite amount of the waters, which contain Sodium, Calcium, Magnesium, Iron and Iodine. Such a combination of measures would manifestly have a powerful influence on metabolism.

Tonics, which increase the tone or general muscular and nutritive vigour, belong, as we have seen, to several of the preceding classes.

III. Pathological Relations.

The disorders of metabolism are many and complex. Diseases so wide apart as gout, syphilis and diabetes, and disorders so different in their cause and effects as fever and fatty degeneration, are linked together by the fact that they are all affections of nutrition. In this place we can refer but to a few of them by way of illustration, and that very briefly.

The causes of metabolic disorder are most frequently found in the *ingesta.* An *excessive* supply of lymph to the active cells, an unnatural richness of the blood in proteids from indulgence in food, or an insufficient supply of oxygen from sedentary habits, will disturb general metabolism as they disturb hepatic metabolism, and contribute to the production of the diseases known as obesity and gout. *Deficiency* of plasma is associated with anæmia, as we saw in Chapter VIII.; and since it generally accompanies aglobulism and deficiency of oxygen, the result is feebleness of metabolism throughout the entire body. Abnormal states of the *internal secretions* occasion grave derangements of nutrition. Metabolism is also disturbed by sudden and extreme alterations of *external natural influences,* such as the temperature, moisture, pressure and electrical condition of the air; and local changes of temperature may give rise to chills, neuralgia

and myalgia. *Wounds and other injuries* constitute a large group of morbid conditions of nutrition. Inflammation, fever, and many other disorders of metabolism are commonly due to the entrance into the tissues of *unnatural, extraneous or infective substances*, whether inorganic, organic or organised, such as foul air, the contagia of syphilis, measles, scarlatina and other exanthemata, and the organisms of malaria and tuberculosis. It is suggested that micro-organisms interfere with metabolism by settling in the blood and tissues, and carrying on an independent metabolism of their own, *i.e.* by living, thriving and reproducing their like at the expense of the pabulum of the tissues; that they throw their products into the blood, which is thus poisoned and infects the rest of the body; and that their life-changes develop heat, which constitutes one factor of fever. *Insufficient exercise* is a fertile source of some of the most important disorders of nutrition, such as obesity, gout and derangements of the liver. *Imperfect removal of the products* of metabolism by the excreting organs is another common way in which it is disordered, as in constipation and nephritis.

The *phenomena* of disordered metabolism are necessarily of endless variety and complexity. The most striking symptoms attend *fever*, viz. wasting, increased excretion, elevation of temperature, and general functional derangement. To this subject we shall return in Chapter XIV. In the present connection *inflammation* may be broadly defined as increase of metabolism in a local form. The effects of defective local nutrition are seen in *atrophy* and in fatty and calcareous *d generations.* In some forms of derangement the results are chiefly appreciable in connection with the tissues themselves, as in obesity; in others they are discovered in the excretions, *e.g.* gravel and glycosuria; in many instances, such as gout, they can be found both in the tissues and excretions. Occasionally they take the form of excessive and unnatural *new growth*, invading and destroying the normal structures, as in cancer. In other diseases the new growth is rapidly followed by decay, as we see in syphilis and tubercle. When the derangement remains persistently, and establishes itself in the system, with occasional manifestation locally, it constitutes in part the so-called *diatheses* —gouty, rheumatic, calculoid, etc. In this great collection of diseased conditions we have an urgent demand for treatment.

IV. NATURAL PREVENTION AND RECOVERY.

The cell is originally endowed with "essential" vitality, possessing a powerful order of natural resistance to degenera-

tion and disease generally. Experience also teaches us that many of the most common derangements of general metabolism, such as fever, gravel, glycosuria and gout, are of but temporary duration, that is, disappear spontaneously when the normal conditions have returned or are restored. Unfortunately derangements of this class are peculiarly liable to recur, because of the return of unhealthy circumstances. The forms which natural recovery takes in local metabolic disorders are known as *reaction and repair*, *i.e.* increased nutritive activity, often associated with *inflammation*, which comprises not only destructive factors—degeneration and necrosis—but also conservative and reconstructive factors, including phagocytosis, immunising processes, regeneration, and removal of the products of disease. Recovery may be limited by anatomical changes; but even fibroid growth, atrophy and degeneration sometimes disappear under favourable conditions.

V. THERAPEUTICS.

The rational treatment of disorders of nutrition is a subject of such large proportions that it can be discussed only in an illustrative way in the present work. A careful consideration, however, of the principles laid down under the preceding heads will, it is hoped, enable the student to extend his knowledge practically on his own account.

The preventive treatment of disorders of metabolism involves the regulation—or it may be the reform—of the whole manner of living: of the food and air, the work done, the excretions, and, above all, the balance of these. Muscular and nervous exercise must be ordered in fair proportion, to prevent obesity and gout on the one hand, or exhaustion and degeneration on the other, whilst the demands of growth and development have to be fully respected in young subjects.

When an actual case of metabolic disorder requires treatment, we must first attempt to *discover the cause; and to remove it* by the same measures which might have prevented its operation. Thus the cause of gout may be swept from the system in many instances by a timely and thorough reform of the diet, whilst the bowels, liver and kidneys are stimulated by a combined cathartic and cholagogue, followed by a saline. Lead poisoning is cured by hastening the excretion of the metal with Potassium Iodide. Various forms of electricity promote the elimination of the cause in chronic alcoholism, metallic poisoning and gout. When these or other disorders of metabolism, such as rheumatism, syphilis and obesity,

have become chronic, great benefit is derived from change of air and treatment with natural baths. Sometimes, on the other hand, if nutrition be disordered by a defect instead of an excess of some metabolic element, this can be supplied: thus myxœdema is immediately remedied with thyroid substance; and fatty degeneration, that striking instance of imperfect metabolism, may yield to fresh air and iron, combined with exercise. In other cases we may attempt to destroy the cause. It is possible (but not certain) that Mercury partly cures syphilis by destroying its virus, and Salicin rheumatism; and there are the different Antitoxins.

As a rule, however, in the more pronounced, the so-called specific, forms of disordered nutrition, such as tuberculosis, cancer and syphilis, all that we can do is to *counteract the cause and relieve or remove its effects* (palliative treatment). The specific fevers, such as typhoid and scarlatina, must receive similar treatment, which is then called *expectant* (waiting) treatment, for their course cannot be arrested. The pyrexia is combated with febrifuges or antipyretics, which we shall discuss fully in another chapter; the waste is controlled with nourishment; and other disorders are relieved as they arise. Inflammation and its effects—abscess, effusions into cavities, growths, adhesions, and so on—will be treated with local stimulants or sedatives, such as poultices; friction with alcoholic, aromatic and oily preparations; douching, baths, blisters, etc., to which we shall return in Chapter XIV. Often they demand surgical interference, antiseptic and operative. In these and in other kinds of metabolic disorders, such as tuberculosis, we direct a considerable part of our treatment to the maintenance of general nutrition, by preserving digestion, giving highly nutritious foods such as Milk, Cod-liver Oil, or an actual excess of ordinary food, and providing abundance of fresh air, until the morbid process has spent itself, and ended possibly with the removal of the diseased parts.

The question of the treatment of syphilis, chronic gout, rheumatism, and a number of local diseases probably related to these, for example, certain diseases of the skin, joints and nervous system, introduces us to the use of so-called "*alteratives.*" We suggested that "alterative" drugs act by *exercising* the tissues, and we have now to point out how exercise benefits an organ actually the seat of disease. For instance, syphilis is characterised locally by masses or patches of small-celled growths, with peculiar anatomical relations, proceeding probably to ulceration, that is, to death of the part. How do Mercury and Iodine remove these

growths and thus cure the syphilis? In answer to this question it may be said that there are two objects for which it might be desirable to exercise tissues. First, there might be need of increased metabolic change in order to remove excessive growth. Mercury and Iodine act, partly at least, in this way upon syphilitic growths. They hasten the life-processes of the young cells so much, that the cells disappear in the form of products, or, as it is commonly expressed, "are absorbed." It is essential to the success of this plan of treatment that the substances used to influence metabolism should be thoroughly under control, and, as we have seen, that abundant food and air be ingested to prevent failure of nutrition.

Secondly, there is an effect of exercise beyond an increase of work accomplished: work that is increased in *amount* can be changed in *kind*. Exercise is beneficial, not only to the indolent individual, but to the vicious. So with the tissues: exercise may bring them into a new, a normal, state of function, when they have been deranged or even diseased. In order to get the tissues to work normally, we must get them to work *somehow*, knowing that such work means chemical change, or even active nutritive renovation of the elements. The natural disposition which all tissues inherently possess to return to the normal under favourable conditions is thus afforded an opportunity of coming into play; and the result is, not a mere increase of activity, but also an *alteration in kind* of the activity. Henceforth the protoplasm, if supplied with an abundance of food and oxygen, itself returns to the normal state. Besides Iodide of Potassium, the medicines used for this second purpose are chiefly Arsenic, Antimony, Phosphorus, Silver, and occasionally Copper and Zinc. Sulphur is a mild metabolic stimulant, valuable in rheumatism and skin diseases, especially as a constituent of natural waters. Many vegetable substances are credited with like properties, notably Sarsaparilla, Guaiacum, Hemidesmus, Serpentary, Aristolochia and Mezereon, but the physiological actions of these are very obscure, and their value as medicines is doubtful.

CHAPTER X.

THE CIRCULATORY SYSTEM.

I. PHYSIOLOGICAL RELATIONS.

THE function of the heart is to drive a certain amount of blood through the whole length of the circulatory system within a given time. In its flow through the arterioles and capillaries the blood meets with peripheral resistance, and is dammed back, as it were, upon the larger arteries, which by virtue of the elasticity of their coats are constantly distended, and exert an equal and opposite pressure on the blood. The intermittent action of the heart is thus converted into a continuous force, *the arterial blood pressure*, which urges the blood forward (thanks to the aortic valves) in a steady stream. The surface of the blood-stream is broken only in the arteries by the wave raised by each fresh discharge from the heart, and this wave is called the *pulse*.

The *heart* performs its work by virtue of being a nervo-muscular organ, freely supplied with blood by the coronaries. Whilst the muscular tissue is automatic in its rhythmical action, the vigour of ventricular systole is in direct proportion to the intra-cardiac pressure, which in turn is referable, partly to the charge from the auricle, but chiefly to the resistance ahead. The movements of the heart are regulated by the *cardiac centre* in the medulla. This is a part of the nervous system where afferent impressions are first received and then reflected as motor impulses to the terminations of the vagus or of the sympathetic in the heart, the effects being, respectively, to diminish continuously the frequency of the rhythmical contractions of the heart, that is, to *inhibit* it, and to *accelerate and augment* them under certain circumstances. With regard to the heart- or pulse-rate, it is highly important to observe that the *length of systole varies very little*: whatever the work to be done, the ventricle takes about $\frac{4}{10}''$ to contract. The part of the cardiac revolution that mainly varies in length is ventricular diastole, which is sometimes long, giving an infrequent pulse-rate, say 50, sometimes short, giving a frequent pulse-rate, say 100. Now, during diastole the nervo-muscular apparatus rests and is nourished more fully (anabolism), and the elastic ventricles

are filled from the auricles and veins. An infrequent pulse is thus (to a certain extent) evidence that the heart is being rested and filling well, whilst the force of systole is not weakened, probably the reverse, by these two effects. Agencies which thus affect the *rate* of the heart through the terminations of the vagus and sympathetic in the myocardium either reach them through the coronary blood, such as drugs, or are transmitted from the central nervous system through the two nerve-trunks. Central impulses affecting the *force* of the heart probably reach it through the same channels.

The *cardiac centre* in the medulla is the centre of an area of impressionable matter as extensive as the nervous system itself. Into this centre there pour constant streams of impressions from the vessels, abdominal viscera, skin, muscles and central nervous system (including the seat of the mind), from the lungs, and indeed from every organ, including the heart itself; and from this centre the resulting impulses descend through the vagus and sympathetic to the heart, which is thus subject to every influence, however slight, to which the body may be exposed. Further, the cardiac centre is affected by its blood supply, including both the quality and the pressure of the blood within it; and by thus influencing the frequency of the heart the arterial pressure is automatically regulated.

Amongst the afferent impressions affecting the cardiac centre are those, as we have seen, which come from the heart itself and travel through the vagus. They are partly impressions of common sensibility, which pass through the medulla into the convolutions, and, although normally too feeble to be perceived, may, if powerful, give rise to sensations of pain, distress, oppression, faintness and palpitation, referred to the præcordia.

The *arteries* are active, irritable muscular tubes, whose calibre can be modified by a variety of influences. A local nervous mechanism guides the vasor muscles; vaso-motor and vaso-dilator nerves pass between the local mechanism and the central nervous system; and there is a great central point in the medulla oblongata, called the *vaso-motor centre*, and other lower centres in the cord, which collect impressions from every part of the body, and reflect them through the vaso-motor or vaso-dilator nerves, as the case may be, to the vessels. The muscular coat of the arteries, particularly of the arterioles, being constantly exercised to a degree, gives so-called "tone" to the vessels, which is the principal element of that cardinal factor of the circulation, *the peri-*

pheral resistance. The more active the arterial muscles or the vaso-motor nerves or centres, the greater the resistance to the passage of blood and the higher the general blood-pressure; the more active the dilator mechanism, the lower the pressure. Particular vascular areas, *e.g.* those of the skin, mesentery, and the viscera during different phases of functional activity, may also be dilated or constricted independently of others. Manifestly local dilatation will admit more blood to the part, and so lower the general arterial pressure; local constriction will increase the local resistance, and so raise the general pressure. Amongst the impressions which influence the vaso-motor centre are mental states, sensations of all kinds, visceral conditions and surface temperature. It is also stimulated by deficiency of blood within itself, or by poverty of the blood in oxygen; and many drugs act directly upon it.

Of the afferent impressions which reach the vaso-motor centre, those proceeding from the heart are so important to the therapeutist as to demand special mention. When impressions originating in over-distension, distress or failure of the heart reach the cardiac centre through the depressor fibres of the vagus, they are transferred to the vasor centre, whence they are reflected to the vessels (mainly in the splanchnic area) through the dilator nerves. The vessels are thus relaxed; the arterial pressure, which the embarrassed ventricle has to overcome, falls; the heart empties itself more readily, and is relieved. This arrangement for reducing the intercardiac pressure is called the *depressor mechanism of the circulation.* Conversely, the peripheral resistance influences the frequency of the heart through the vaso-motor and cardiac centres and the vagus, and thus is self-regulative.

The *capillaries* effect the final distribution of blood to the tissues. Their soft protoplasmic walls, through which the plasma, the oxygen, and the corpuscles pass into the tissues, have irritability of their own, and they are subject to many other influences, viz. those of the nervous system, of the blood which they contain, of the arteries and the veins at either extremity, and of the activity of the cells which they nourish. In the capillaries we discover another but relatively feebler element of the *peripheral resistance.*

The *veins* convey the blood back to the heart as comparatively passive tubes fitted with valves. They are probably controlled by special nervous influences, but they are chiefly influenced physically—by posture, muscular movements, respiratory activity, and by the volume of blood passing through them, that is, by the condition of the heart in front

and of the arteries and capillaries behind. Shortness of diastole, *i.e.* frequency of the heart, diminishes the time of emptying the veins, and raises the pressure within them. A low arterial pressure and a free flow through the capillaries have the same effect. Conversely, the veins react physically on the heart and capillaries; if they are dilated, the return of the blood to the auricle is delayed, and the force of systole weakened from lowness of the charge, whilst the capillaries are obstructed, and the flow of the plasma and metabolic products between the vessels and the tissues is disturbed.

We now can understand the meaning of the expression, *the general blood-pressure.* The elasticity of the arteries being taken as constant, the pressure of blood within the arterial system at any given moment will depend upon (1) the total quantity of blood in circulation; (2) the force and frequency of the action of the heart; (3) the freedom of the flow into the veins, *i.e.* the peripheral resistance, due to vasor constriction or relaxation, as the case may be, particularly in the splanchnic vessels. The arterial pressure is also self-regulated, through the quantity of blood in circulation, by means of the Malpighian bodies of the kidney. In this mechanism, the general arterial pressure is brought to bear upon a length of unsupported capillaries, so as to press or excrete the water of the blood through the vascular walls into the uriniferous tubule. By the muscular and nervous structures in the walls of the afferent and efferent arterioles, the pressure upon the glomerulus may be cut off or thrown on as the system requires, the result being less or more watery excretion, and corresponding rise or fall of the blood-pressure. The perspiratory excretion, and, indeed, all excretions, probably act in the same way as the urinary, only less powerfully.

Another influence on the circulation as a whole is muscular activity, exertion being attended by increased influx of venous blood, cardiac excitement and high arterial pressure; muscular rest by diminished venous charge, calm action of the heart and a quiet pulse.

II. Pharmacodynamics.

The circulatory system affords one of the most striking instances in the body of provisions for physiological change; and of accurately adapted reaction to influences of every kind that may be brought to bear upon it. Herein lie at once its capacity of adjustment to varying circumstances, and its vulnerability; here, too, the therapeutist discovers an opportunity of influencing heart and vessels at pleasure.

1. The *total volume of blood in circulation* being one of the prime factors of the blood-pressure, every change in this volume, whether by abstraction or addition, must alter the pressure. This can readily be accomplished by leeching, cupping or *venesection* on the one hand, or by *transfusion* on the other hand. The effect of either method on the circulation is temporary. The tension of the pulse falls with venesection, and rises again by increased absorption of fluids from the tissues and bowels. Transfusion of blood, or of normal saline solution, raises the blood-pressure for a time, but the compensating mechanisms soon restore the previous average pressure. Venesection is therefore the most powerful of all measures for quickly taking the tension off the whole circulation, and relieving the heart and lungs, but it is useless for permanently reducing the blood-pressure; transfusion is similarly of inestimable value in rapidly restoring the pressure, if it have fallen dangerously low from loss of blood or other cause, and thus in preventing death from circulatory failure.

2. *The heart.—a. The intrinsic nervo-muscular apparatus* may be either *stimulated* or *depressed.* The first *direct cardiac stimulant* is an active coronary circulation. Through it the heart responds to improved quality of the blood in oxygen and plasma, and thus, indirectly, to better air and food, and to healthy digestion and hepatic action. Direct cardiac stimulants include many drugs, such as Alcohol, Digitalis, Strophanthus, Squill, Strychnine, Suprarenal Substance, Ammonia and Ether. *Reflex* stimulation is a ready and powerful means of increasing the activity of the heart, or of rousing it in actual arrest. It includes the various methods of local nervous stimulation described in Chapter XII., especially irritation of the fifth nerve with Ammonia, the cold douche and flagellation, and counter-irritation of the præcordia. Cupping and leeching exert a stimulant influence on the heart through the nervous system, as well as relieving it by abstraction of blood. Carminatives stimulate the heart—in part directly, in part by reflexion through the central nervous system of their impression on the gastric mucosa. *The mind* is a powerful instrument for invigorating the heart. Cheerfulness and encouragement may be more useful to a patient than many drugs. Produced by any of the preceding measures, cardiac stimulation raises the blood-pressure.

The intrinsic nervo-muscular apparatus may be *depressed or quieted* by the opposite set of measures: by a low coronary pressure—the effect of venesection, low diet, purgatives,

diuretics, and diaphoretics; and by arresting reflex impulses with general, peripheral and central nervous sedatives, such as Opium, warmth, cold compresses or ice, plasters applied to the præcordia, and the warm bath. Lastly, we have a number of drugs that are direct cardiac depressants, including Opium, Diluted Hydrocyanic Acid, Aconite, Antimony, Ipecacuanha, Potassium, Chloroform, Chloral Hydrate, Ergot, Veratrine, and many more. The same measures might be employed to lower the general blood-pressure.

The *afferent nerves of the heart*, which carry to the brain the impressions of common sensibility originating in the cardiac tissues, may be depressed by Opium, Chloral Hydrate, Belladonna and its allies, and possibly by heat and cold.

b. The terminations of the vagus in the heart may be *stimulated*, and the cardiac action rendered less frequent, by Digitalis, Strophanthus and Squill. The same part of the inhibitory mechanism may be *depressed*, and the rate of the heart increased, by Belladonna, Hyoscyamus, Stramonium, Amyl Nitrite, and large doses of many drugs. These local measures act very powerfully.

c. The *cardiac centre* in the medulla is readily *stimulated* by certain drugs, such as Digitalis, Strophanthus and Squill, Ether, Alcohol and Chloroform at first, Strychnine, and Belladonna; and by many peripheral nervous impressions, such as counter-irritation and cold. Therewith the arterial pressure is raised. Again, it can be *depressed* by venesection, warm applications to the surface, such as the hot bath, and by certain drugs, including Chloroform and Alcohol after the first stage, Aconite, Antimony, Opium, Chloral Hydrate, Diluted Hydrocyanic Acid, Ipecacuanha, Amyl Nitrite, Physostigma and Conium. The arterial pressure necessarily falls.

Our control of the inhibitory action of the vagus at either extremity, that is, of the frequency of the heart, is of much value from the power which it affords us of influencing the cardiac nutrition and strength, by either lengthening or shortening the diastole or resting-time of the ventricle. Thus it will be found that all cardiac retarders are cardiac stimulants, whilst all cardiac accelerators prove in the end to be cardiac depressants.

In this connection muscular *exercise and rest* must be mentioned as the most powerful and available of all the measures that increase and diminish, respectively, the work and nutritive activity of the heart. Rest in bed, avoidance of walking, carriage exercise, movement on level ground, are a descending series of means of giving the heart rest; and

the different kinds of wholesome muscular exercise or formal "movements" are equally valuable means of throwing work on the heart, when its condition demands increased activity.

3. *The Arteries.*—The peripheral resistance in the arteries introduces us to a large number of pharmacodynamical influences which we must be content simply to enumerate:

a. The vaso-motor centre can be *stimulated* directly, and the blood-pressure increased, by Alcohol and Chloroform (temporarily), by Ether, Ammonia, Strychnine, Digitalis, Strophanthus and Squill; by irritation of the sensory nerves in any accessible part of the body—for instance, by cold, counter-irritants such as mustard, etc., applied to the calves or soles, and by stimulation of the trigeminus, the most ready and powerful means of which is Ammonia held to the nose. On the other hand, the vaso-motor centre may be directly *depressed*, and with it the blood-pressure, by Alcohol and Chloroform in the second stage, by Opium, Chloral Hydrate, Diluted Hydrocyanic Acid, Antimony, Ipecacuanha, Aconite, Belladonna and its allies; by muscular rest; by emotional quiet and balance; by local sedatives, such as anodynes, warmth and gentle friction; and temporarily by bleeding.

b. The local vaso-constrictor mechanism in the arterial walls is stimulated directly, and the blood-pressure increased, by Lead and Silver, by Suprarenal substance, by Digitalis and Strophanthus in the first stage, and by Ergot. Local contraction can be effected by cold, induced by irrigation with water, by Ether spray, or by evaporation of spirituous acid or saline solutions, such as lotions of Rectified Spirit, Vinegar and Ammonium Chloride. We call these measures **vascular astringents.**

Vascular *dilatation* may be effected through the same local mechanism by the Nitrites of Amyl and Sodium, Trinitrin, Alcohol, and Belladonna; by the local heat afforded by poultices and fomentations; by the whole group of Volatile Oils, of which Turpentine and Camphor are the types; by Acrid Oils, including Mustard and Mezereon; by irritant metals and metalloids, such as Zinc, Copper and Iodine; and by artificial carbon compounds, including Creosote, Phenol and their allies. Local vascular dilators are naturally **local circulatory stimulants.** The continuous current also causes local vascular dilatation.

4. *The Capillaries.*—As a minor element of peripheral resistance, the condition of the capillary areas is an object of great interest to the therapeutist. We can *dilate* the capillaries and increase the flow through them by either local warmth or persistent cold, by friction, and by local nervous

irritants, such as the confined vapour of Spirits, Mustard, Aromatic Oils and other rubefacients. This is but an early stage of the inflammation, characterised by capillary dilatation and escape of the constituents of the blood, which can be induced by a continuation of the same measures, or by excessive heat, Cantharides, Mylabris, Croton Oil, etc. (vesicants and pustulants). It markedly modifies the capillary circulation of neighbouring parts, and also the general blood pressure, as we shall see in Chapter XV.

On the other hand, we can *contract* the capillaries and diminish the flow through them by the application of excessive local cold (congelation and refrigeration); by Lead and Silver, which are pure astringents; and by the **constringents**, namely, Tannic Acid and the many vegetables which contain it (Kino, Catechu, Acacia Bark, etc.), which constringe or "tan" the connective tissues supporting the delicate capillaries, by condensing their gelatinous and albuminous constituents. Some substances, such as Ferric salts, may also arrest the circulation in the capillaries by promoting coagulation of the blood within them.

5. Our influence upon the walls of the *veins* appears to be but small. The veins of a part may be dilated by hot applications; contracted, and then dilated, by moderate local cold. Ergot is believed by some authorities to relax the venous walls. Indirect measures are more powerful in our hands, such as support with bandages, posture and friction. The heart *a fronte*, or the arterial pressure *a tergo*, may be employed, as we have seen, to increase or diminish the venous pressure. The processes of secretion and excretion are not less powerful in modifying the fulness of the veins. Thus, hydragogue purgatives drain the portal system; and we shall find afterwards that saline diuretics relieve the renal veins in a very similar way. Venesection directly reduces venous fulness.

III. Pathological Relations.

The complex circulatory apparatus is subject to many forms of derangement and disease, a few only of which require to be noticed for the purpose of illustrating the application of drugs and other therapeutical measures.

1. *Disorders* of the heart and vessels belong chiefly to three classes, according to their causes: (*a*) They may be due to direct *nervous* causes, including mental excitement or depression, or to some cause acting reflexly through the nervous centres in the medulla, such as derangement of the stomach, intestines or uterus. (*b*) They may originate in

morbid states of the *blood*, especially anæmia, which disturbs the centres in the medulla, the vessels and the nervo-muscular structures in the heart. Or (*c*) they may be traced to a *poison* in the system, *e.g.* tobacco, tea, alcohol, lead, and the poison of gout, each of which has a specific action on some part or parts of the mechanism.

2. *Structural disease* of the heart will be sufficiently illustrated by the course of a well-marked case of lesion of the aortic valves. These valves, from their position and constant movement, are peculiarly subject to damage in inflammation of the endocardium. They may become distorted or even destroyed, and unfit to direct the proper movements of the blood. This is obstructed in its discharge from the left ventricle during systole—a condition that induces more powerful contraction; and a part of it regurgitates from the aorta during diastole—a condition that overfills the ventricle and also provokes a more powerful systole. This great power of *adaptation* to change of circumstances (*i.e.* overwork) possessed by the circulation is generally sufficient to *compensate* for the valvular lesion, by leading to hypertrophy of the left ventricle. The serious symptoms set in *when compensation fails, i.e.* as a rule, when the nutrition of the myocardium is insufficient to supply the increased—possibly ever-increasing—demand for muscular force. The order of events is then as follows: systole fails to overcome the intraventricular pressure; *the chamber is insufficiently emptied*, and therefore over-distended in diastole; the walls are stretched; the cavity becomes *dilated*. Pain and "oppression" make their appearance at this stage, and cause great distress. Henceforth derangement proceeds apace. With the dilatation of the chamber, the mitral valve becomes incompetent or misfitting; blood regurgitates in systole into the left auricle; the pulmonary circulation becomes over-distended; the obstruction makes itself felt in the right ventricle, and, after a time, in the right auricle, by forcing the tricuspid. The systemic veins now become congested from obstruction *a fronte;* the viscera become loaded with venous blood; their functions are disordered; and hæmorrhage, dropsy, fluxes of plasma from the bowels and bronchi, and discharges of albumen in the urine occur. These derangements, coupled with those of respiration, the cardiac distress, and the effects of anæmia from imperfect arterial supply, finally render life impossible. During this process of backward dilatation, the cardiac action is necessarily disordered in all respects, the strength and regularity of the heart giving way, and its rate being decidedly accelerated,

whilst it is impoverished by the slow visceral deterioration, and embarrassed by flatulent distension of the stomach and bowels.

3. *Hæmorrhage.*—Bleeding produces certain effects on the system, partly referable to loss of blood, partly to fall of the blood-pressure. It is naturally arrested by this fall of pressure; by coagulation of the blood at the seat of lesion, and by retraction of part of the coats of the vessel. If the hæmorrhage be severe, fainting or *syncope* occurs, that is, loss of consciousness from failure of the heart and deficiency of blood, of velocity of flow, and of blood-pressure in the brain. Any other cause of cardiac failure will produce the same effect. At the same time, the weight of the body cannot be supported on account of the general muscular paralysis which is another result of the cerebral anæmia; and the patient falls. The recumbency fortunately has a favourable effect: it restores the circulation through the cardiac and vaso-motor centres, increasing their activity; and renders the cerebral centres more responsive to afferent impressions.

IV. Natural Prevention and Recovery.

The whole circulatory system is furnished with so many and so accurate regulating and compensating mechanisms, that not only the great range of normal conditions to which it is exposed, but even many morbid changes, can be successfully met by these, which serve as provisions for preventing or counteracting disease. The great distensibility of the cardiac walls, the safety-valve action of the tricuspid opening, the arrangements for the relief of the right auricle and veins backwards into the viscera and extremities, the further relief of these vessels by escape of serum through the bowels and into serous spaces, and the depressor mechanism, all diminish the risk of distress, disorder and damage *within* the chambers. On the other hand, an abnormal rise of *peripheral* resistance is counteracted by a fall of cardiac frequency, effected through the vagus; and it is met at the same time, and chiefly, by increased reaction, originating in the large reserve of energy (*i.e.* the wide range of working capacity) possessed by the heart. If disease have arisen in spite of these provisions, repair is active and general within the heart and blood-vessels; but often it is imperfect, from the impossibility of more than the partial rest of the circulation compelled by pain, dyspnœa and other forms of distress. Valvular or vascular lesions are the result. How compensatory hypertrophy then occurs, and how it may afterwards fail, has been related already. The natural pro-

visions for recovery from hæmorrhage and syncope also have been noticed. All these methods of automatic relief are full of suggestions to the therapeutist, and rational treatment must follow Nature's lines.

V. THERAPEUTICS.

Although the details contained in the four preceding sections are very numerous and complex, the rational therapeutics of the diseases of the heart and vessels can be sufficiently illustrated by a few simple principles. The grand fact that stands out prominently amongst all the others is that dilatation of the heart from insufficient emptying must be prevented or relieved. This kind of dilatation is a purely physical effect or state, but it results from failure of the physiological condition on which alone the circulation is or could be carried on, namely, that the driving power must always be greater than the resistance: that whilst it varies with it, it must never fall below it. There are many other indications for treatment, but none that approach this in importance.

In *the prevention and removal of dilatation* of the heart from insufficient emptying, the first rational step is *to lower the intraventricular pressure* which the organ fails fully to overcome. Rest, bodily and mental, is the most obvious and easy means of securing this end, the patient being kept in bed or seated in an easy chair, and every kind of exertion and excitement forbidden. The pressure may be further reduced by purgation, which diverts and drains the blood; or, if the condition be urgent, blood must be removed by leeching, cupping, or venesection, all of which may give great relief, or even preserve life when it is threatened. In another class of cases, the peripheral resistance can be lowered by means of drugs. Amyl Nitrite acts very swiftly in this way, giving relief in that terrible form of acute distension of the heart and aorta called "angina pectoris," by instantly relaxing the vessels in front, as well as by accelerating the cardiac action. The same effect is produced more slowly by Nitroglycerin, the alkaline Nitrites, Erythrol Tetranitrate, Potassium salts and Belladonna; and by Nauheim baths (page 613).

The second means of treating dilatation is by *increasing the cardiac energy with direct cardiac stimulants*, such as Digitalis, Strophanthus, Caffeine, Strychnine hypodermically, Alcohol and Ammonia. At the same time, the quantity and quality of the blood supplied through the coronaries to the cardiac walls must be sustained by nutritious food, and

possibly by Iron: a system which demands, in turn, the strictest attention to the diet, and to the action of the stomach, bowels and liver; flatulence and other digestive disturbances, which are often present in dilatation, being highly dangerous to a weak heart. Mustard or other rubefacients applied to the præcordia are of great value in some cases as *indirect* cardiac stimulants.

The third means of treating dilatation is by *increasing the time of cardiac rest.* The direct cardiac stimulants, Digitalis, Strophanthus, Squill and Convallaria, have the additional action of stimulating the inhibitory apparatus, both in the heart and medulla: whilst they increase the force of the systole, thus thoroughly emptying the chamber and preventing over-distension, they lengthen diastole—the time of filling the heart, that is, of emptying the veins—and thus favour the venous flow, and they afford rest to the ventricle and thus promote anabolism. Finally, they maintain the arterial pressure, not only by filling the aorta better, but also by stimulating the vaso-motor system. In a word, they combat that backward dilatation of chamber after chamber, ending in visceral congestion and dropsy which we have discussed, and they prove of great value in practice.

Removal of effects: palliative treatment.—Cardiac pain, oppression, anxiety, and other forms of distress decline and disappear as dilatation yields to treatment; but they may be relieved by cardiac sedatives, such as local heat or cold, Opium, Chloral Hydrate and Belladonna. Of these, Opium is the most powerful, and of the greatest value. We must never forget, however, that in Opium we are administering a dangerous cardiac depressant, which in large doses paralyses every part of the circulatory apparatus; and the same remark applies to Chloral Hydrate. The perfection of the therapeutic art is to use these remedies with judgment. The Hypodermic Injection of Morphine is the best preparation, whether alone or combined with Strychnine. Belladonna as a cardiac anodyne is less depressant, but much less efficacious. It may be applied to the præcordia as the Emplastrum. A rubefacient effect on the chest or the application of leeches quickly relieves cardiac pain. Pulmonary distress from congestion of the bronchi and alveoli may be removed by stimulant expectorants, such as Ammonia and Squill, which increase and remove the bronchial flux; but here again the value of rational treatment is seen in the disappearance of dyspnœa, hæmoptysis, cough, and the physical signs of pulmonic engorgement, under the influence of purely cardiac remedies, such as Digitalis and Alcohol. Dropsy may be

immediately relieved by puncture of the part, but like other effects disappears rapidly by the veins when the cardiac strength is restored. The same remarks apply to the visceral congestions and their temporary relief by purgatives. Diuresis is not only of favourable significance but of great service in cardiac dropsy, as a result partly of relief of the renal veins by salines, but chiefly of the actions of Digitalis and Squill, as is fully discussed under the head of The Kidneys in Chapter XIII.

The *general* treatment of disorder and disease of the heart will consist in ensuring an equable manner of life. Extraordinary influences of every kind, bodily and mental, especially exertion and excitement, must be shunned by persons suffering from cardiac disease, or in whom its common causes may be at work. *Control of these causes* is often practicable. It consists in combating the rheumatic poison with Salicylates, septicæmia with serums, syphilis with Mercury or Iodides; in restoring the condition of the blood; in securing bodily and mental rest; and in removing all poisons from the system, such as alcohol, tea and tobacco, by a reformation of diet and personal habits. Carminatives are specially valuable in palpitation from dyspepsia. When disease affects the valves (endocarditis), *e.g.* in acute rheumatism, absolute rest is essential, to diminish the stress on them and the frequency of their movements; and cardiac depressants, such as Potassium, Salicylates, Aconite and Veratrine, given cautiously, promote this effect.

Hæmorrhage—Hæmostatics. — External hæmorrhage is readily arrested by surgical means. If the lesion be internal, as in the stomach or lungs, we must trust chiefly to medicinal remedies which are known as **hæmostatics**:—

(*a*) So far the *cardiac depression* caused by the hæmorrhage may be cautiously encouraged. It is desirable to employ all available means of reducing the force, not the power, of the heart, especially bodily and mental rest; and for this purpose general sedatives—particularly Morphine hypodermically—are invaluable adjuvants to the more direct measures.

(*b*) It is also desirable to take the pressure of the circulation off the bleeding point by *dilatation of a vascular area* in the neighbourhood and in anastomotic connection; or by inducing a watery flux from it. We therefore employ purgatives in gastric hæmorrhage due to portal congestion, in hæmoptysis referable to pulmonary congestion, and in cerebral hæmorrhage; our object being to dilate the mesenteric vessels and produce a hydragogue action of the bowels.

(*c*) The *local* measures employed in hæmorrhage are variously known as **local hæmostatics, styptics,** or local vascular astringents. They are imitations or adjuvants of the natural means just analysed, and belong to three distinct classes, according as they act upon, (1) the *blood*, (2) *the vessel walls*, or (3), the *perivascular tissues.*

(1) Hæmostatics may act upon the *blood*, hastening coagulation or precipitating albumen, and thus stopping the bleeding point. Such are Calcium Chloride, Alum, Ferric salts, Copper Sulphate, Lead Acetate, Silver Nitrate and Diluted Mineral Acids.

(2) The hæmostatics which promote *contraction of the broken vessel* are Silver Nitrate and Lead Acetate; Suprarenal Body; Ergot; local cold; and water at 110° to 120° F.

(3) Substances acting upon *the perivascular tissues* may be made to arrest hæmorrhage by combining with the connective tissues, coagulating or precipitating their albuminous substances, and rendering them more compact than normal, or constringed, so that the bleeding vessels are compressed and closed. Such are: Tannin and its allies, Lead, Silver, Copper, Zinc, Ferric salts and Alum.

The anæmia which results from hæmorrhage urgently calls for treatment.

Syncope.—Syncope demands prompt treatment. Nature suggests the first step: the patient must be laid down, with the head at least as low as the heart, so as to restore the pressure and the blood in the cardiac centre. Every possible means must then be used to increase the action of the heart, including direct and indirect cardiac stimulants. The most available of these internally are Ammonia and Alcohol in the form of spirits or wine; externally, the application of cold, fresh air, flagellation or flicking with wet towels, Ammonia held to the nostrils, and the continuous current to the præcordia. Amyl Nitrite acts quickly in some cases. If swallowing be impossible, Brandy or Ether must be injected into the rectum or under the skin.

CHAPTER XI.

THE RESPIRATORY SYSTEM.

I. PHYSIOLOGICAL RELATIONS.

THE *red corpuscle* of the blood is the oxygenating or respiratory element of the body. The physical part of respiration is carried on by means of the chest and respiratory passages, a fresh supply of oxygen being continually presented to the red corpuscles in the lungs, and carbonic acid, water and heat given off from the plasma.

The red corpuscle and the chest are brought into functional relation with each other by means of a special nervous mechanism, called the *respiratory centre*, a portion of nervous matter in the medulla oblongata which is peculiarly irritable, and sends motor impulses through the cord to the respiratory muscles. The greater the amount of carbonic acid and the less the amount of oxygen admitted to the respiratory centre, the more powerfully is it stimulated, and the chest moved; the less the carbonic acid and the more the oxygen in the blood that reaches the centre, the less powerful are its discharges, and the more weak or superficial is the breathing. Now the amount of the two gases in the arteries of the medulla is the same as in the systemic arteries generally; and we thus find that the state of oxygenation of the arterial blood influences the respiratory movements through the medium of the respiratory centre.

The term "centre" implies that other influences affect the nervous mechanism of respiration and meet in it, originating in a circle, of which it is the middle point. Falling into the respiratory centre are impressions conveyed by afferent (including sensory) nerves, from every part of the body, modifying its activity, and reflexly influencing the respiratory movements. The vagus is the special afferent nerve of respiration. It is continually in action. The whole surface of the respiratory passages and particularly the lungs are supplied with rootlets of the vagus, which incessantly collect impressions, that are transmitted as impulses to the centre, and are there reflected. Thus the inflation of inspiration induces expiration; the recoil of expiration provokes the next inspiration. Every change in the distension of the lungs

thus instantly tells on the respiratory movements. It must also be carefully noted in this connection that venosity of the blood, whilst increasing the respiratory activity, stimulates the other two great centres in the medulla, increasing the arterial resistance through the vaso-motor centre, and slowing the heart through the cardiac centre.

The afferent impressions from the lungs and respiratory passages, besides falling into the respiratory centre, also reach, if sufficiently powerful, the convolutions, where they are felt as various *sensations*, referred more or less accurately to the respiratory organs. In health these sensations of common sensibility are feeble; and we do not appreciate them until they are converted into sensations of pain, oppression, distress, or irritation, in disorder or disease, which in turn stimulate the respiratory centre.

Amongst the nerves of the respiratory muscles one group demands special notice, viz. those distributed to the bronchi. These are motor filaments of the vagus, which originate in the respiratory centre and supply the muscles regulating the calibre of the air-tubes. They bring the bronchi under the control of the medulla, and thus of the afferent impressions, especially of those very impressions which originate in the respiratory passages, the seat of their own distribution.

II. Pharmacodynamics.

The extensive relations of the respiratory organs to the external air, to the blood and circulation, and to the nervous system, afford us abundant means of influencing their mode of action. These means we will now review in their natural physiological order:

1. *The Air.*—The air which comes in contact with the organs of respiration may be altered in five different respects, each of which will have a physiological effect, viz. as regards (*a*) its *absolute amount*, (*b*) its *chemical composition*, (*c*) its *temperature*, (*d*) its *moisture*, and (*e*) its *pressure*.

(*a*) The supply of air, like the supply of food, may be entirely *arrested* for a time, another gas with different physiological properties, such as Nitrous Oxide, being allowed to take its place. Or the amount respired may be simply *reduced*, by administering rarefied air; or *increased*, by admitting oxygen or compressed air into the lungs. The same effects may be produced by ordering little or much muscular exercise respectively.

(*b*) The *chemical composition* of the atmosphere, physiologically speaking, relates only to the amount and quality of

the oxygen. The proportion of oxygen to nitrogen in the air might be modified by arrangements for special inhalation. Life in the open air, and mountain and ocean climates in particular, afford a satisfactory supply of pure air.

(*c*) The *temperature* of the air respired may be modified either by selecting particular climates—tropical, sub-tropical, temperate, or cold; by artificial regulation of the atmosphere of the room—ventilation, heating, etc.; or by arrangements for warming or cooling the ingoing current of air only, by means of so-called "respirators," and by recommending nasal breathing only, or oral breathing only, as the case may be.

(*d*) The amount of *moisture* in the air respired can be altered at pleasure, whether by residence in a dry climate or in a moist climate, or by varying the amount of watery vapour in the air of the room, or in the individual inspiratory draughts, by means of steam kettles, hot-water inhalations, etc.

(*e*) Lastly, the *pressure* of the air is completely under our command; and this again either by means of climate (elevated mountain residence), or by local artificial arrangements such as the air-bath and pneumatic apparatus. The *compressed air-bath*, at a pressure of $\frac{1}{5}$ to $\frac{1}{2}$ of an atmosphere above the normal, increases the amount of oxygen admitted into the blood, as well as the vital capacity and the size of the lungs, whilst it renders respiration less frequent and more easy. A rarefied atmosphere is never given as a bath; on elevated mountains it increases the depth and frequency of respiration and the vascularity of the lungs, so that there is a tendency to hæmorrhage from the alveoli. The *pneumatic apparatus*, a small gasometer, admits air under artificial pressure to the respiratory passages only, the patient breathing into, or out of, a valved tube connected therewith. Inspiration of air compressed by about $\frac{1}{30}$ atmosphere increases the amount of air entering the chest, and eventually the vital capacity, the size of the chest, and the respiratory force, whilst it diminishes the vascularity of the lungs and raises the arterial pressure. The other methods of *aërotherapeutics* do not require mention here.

2. *The Red Corpuscle.*—The red corpuscle is an important agent through which the respiratory activity may be modified by food, drugs, and all the ordinary natural influences. It is studied in Chapter VIII.

3. *The Circulation.*—The blood must be circulated by the heart and vessels, and any effect that we may produce upon these will greatly modify the respiratory functions. The pharmacodynamics of the circulation are discussed in the preceding chapter.

4. *The Lungs and Air-passages.*—(*a*) *Ciliary action* is increased by Oxygen and dilute Alkalis, diminished or arrested by carbonic acid, by Ether and Chloroform vapours; (*b*) *the afferent or sensory nerves* of the respiratory organs are *stimulated* by cold and dry air, Chlorine gas, Ipecacuanha, Senega, Tobacco, Nitre fumes, Ammonia and Antimony: the effect is to increase the activity of the respiratory centre, and so of the thoracic movements. They are *depressed* or soothed by warm and moist air, warm food, warm applications to the chest wall; possibly by demulcent substances to a small extent; and by Opium, Chloral Hydrate, Chloroform and Ether: respiratory movements are thus controlled. *Sensations* connected with the respiratory organs may be modified by the same means, the nerve depressants thus proving to be pulmonary anæsthetics or anodynes, as well as interfering with reflex respiratory acts, such as cough.

(*c*) *The vessels of the bronchi* may have the circulation through them *increased* by all measures which increase the activity of the circulation generally, viz. by bodily movement, exercise of the lungs, and purgation, by Digitalis, Squill, Ammonia, Alcohol, Strychnine, and probably the whole series of Aromatic Oils to be presently noticed. *Per contra*, the bronchial circulation may be *depressed* by all cardiac and general vascular depressants, including heat, Alkalis, Iodides, Aconite, Antimony, Tylophora and Ipecacuanha.

(*d*) *The pulmonic circulation* bears very complex relations to the respiratory movements, as regards the pressure and rate of flow in inspiration and expiration, ordinary and extraordinary. Manifestly as regards the general circulation, the pulmonic vessels may be modified by every influence which affects it, such as blood-letting, transfusion, purgation, a variety of drugs, and muscular rest or exercise. We possess one substance, non-official, which specifically contracts the pulmonary vessels, namely Muscarin, the active principle of the mushroom.

(*e*) *Glands of the bronchi.*—The secretion of bronchial mucus may be *increased* by alkalis, especially Ammonia; by Iodine, Sulphur and Antimony; by Ipecacuanha, Senega, Tobacco, Squill, and the great group of Aromatic Volatile oils, Oleo-resins and Balsams, including Turpentine, Camphor, Benzoin, Copaiba, Ammoniacum, and the Balsams of Peru and Tolu. Warm liquid food also increases the bronchial secretion; on the contrary, cold dry food *diminishes* the bronchial mucus, as possibly do Belladonna, Stramonium and Hyoscyamus, and certainly acids.

(*f*) *The nervo-muscular structures* of the bronchi and

larynx are *stimulated* reflexly by those measures which act upon the afferent nerves (*a*), and perhaps they are also directly influenced by some of the same.

A group of substances of great therapeutical interest directly *depress* the same system, and so relax the bronchial walls and favour the movements of the respiratory air, viz. Belladonna, Stramonium, Hyoscyamus, Datura, Grindelia, Lobelia and Tobacco; Opium, Chloral Hydrate and Cannabis Indica; Chloroform, Ether, Amyl Nitrite, and Ethyl Iodide; Conium, and warm moist air.

5. *The Respiratory Centre.*—Most of the measures enumerated under the preceding four heads influence the respiratory movements also through the respiratory centre, *e.g.* the air, the blood, the circulation, and specially the afferent impressions from the respiratory passages and lungs.

Impulses reaching the respiratory centre through *other channels than the vagus* afford us a remarkably ready means of affecting it. *Stimulating* measures include irritation of the fifth cranial nerve in the nose by Ammonia, or on the brow by cold; of the olfactory nerve by odoriferous substances; of the optic and acoustic nerves by powerful light and sounds respectively; and of the nerves of the skin generally by painful impressions, such as flicking with towels, flagellation or slapping, extreme heat, the sudden application of cold as in the cold bath or douche, mustard plasters, and other powerful local irritants. Or we may use measures with a *sedative* influence on the respiratory centre, including gentle warmth to the surface of the chest in the form of poultices and fomentations; warm baths; and local anæsthetics or anodynes, such as plasters and liniments of Opium, Belladonna, and Volatile Oils (Turpentine, Camphor, etc.).

Besides all those, a variety of *direct* stimulants and depressants of the respiratory centre are in our possession. The force of the nervous discharges may be *increased* by Ammonia, Strychnine, Belladonna, Stramonium and Hyoscyamus; probably by Ipecacuanha and Antimony temporarily; and by Alcohol, Ether and Chloroform for a brief period at the commencement of their action. On the other hand, the last-named drugs quickly *diminish* the force of the respiratory centre (Ether less rapidly than the others); and the same effect may be produced by means of Chloral Hydrate, Opium, Aconite, Veratrine, Conium and Physostigma.

6. *The Tracts of the efferent impulses from the Respiratory Centre, the Spinal Centres* of the respiratory muscles, and *the Nervo-muscular Apparatus* of the chest and larynx may be *stimulated* not only reflexly, but directly, by Strychnine,

which especially increases the vigour of the spinal centres; by electricity applied to the nerve trunks (phrenics, intercostals), or to the muscles directly; and by all measures that improve the nutrition oi the nervo-muscular tissues, such as well-ordered exercise. Conversely, these parts may be *depressed* by Physostigma, which generally diminishes the vigour of the spinal centres; by Conium, which paralyses the motor nerves; and by Opium, which depresses the whole efferent mechanism. The use of these depressing measures is almost confined to the muscles of the larynx. Most powerful of all is the method of arresting, or at least controlling, the movements of the chest by direct restraint, which is best accomplished by means of strapping or bandaging; and simple bodily rest and the prevention of cough have a similar effect.

If we now review the measures classed under the 1st, 4th, 5th, and 6th preceding heads, we are enabled to re-arrange several of the most important of them into new groups with definite pharmacodynamical properties and important therapeutical bearings. These groups are: (A) *Expectorants*, (B) *Antispasmodics*, and (C) *Respiratory Sedatives*.

(A) **Expectorants.**--Expectoration, the discharge of the sputa, or secretions and other products of the respiratory passages, will manifestly vary with the *amount* and *characters* of the sputa, and with the expulsive *force* which can be brought to bear upon them. Measures are therefore called *expectorants* which increase the absolute amount of sputum formed, which so modify its characters as to facilitate its expulsion, or which evacuate it with greater ease: the first and second kinds of expectorants acting upon the glands, the third kind upon the muscular structures. Regarded otherwise, expectorants will be found sometimes to stimulate the respiratory centre, *e.g.* Ammonia and Ipecacuanha, sometimes to depress it, *e.g.* warm, moist air. But of greatest practical importance is the concomitant action of expectorants upon the circulation; and according to their stimulating or depressing influence in this respect, they are commonly divided into (*a*) *Stimulant expectorants*, and (*b*) *Sedative expectorants*. It must be clearly understood that "sedative" and "stimulant" in this connection refer *not* to the respiratory but to the circulatory effect of the bronchial measures.

(*a*) **Stimulant expectorants** include Ammonia, Squill, all the Volatile Aromatic Oils, Oleo-resins and Balsams enumerated above; Strychnine, Alcohol, Senega, Adhatoda, warm liquid food, and moderate exercise of the body generally, or of the chest.

(*b*) **Sedative expectorants** include Alkalis, Iodides, Antimony; Ipecacuanha, Calotropis and Tylophora; warm, moist air; and warm, moist applications to the chest walls.

If we wished to construct other groups of expectorants we might add:

(*c*) **Expectorants with a sedative effect on nerves.**—These are chiefly obtained by combining expectorants with Opium, *e.g.* Pilula Ipecacuanhæ cum Scilla, Tinctura Camphoræ Composita, Tinctura Opii Ammoniata, Pulvis Ipecacuanhæ Composita, Antimony and Opium, etc. Warm drinks have the same effect.

(*d*) **Expectorants which alter the chemical composition of the sputa.**—This is a highly important group. Alkalis increase the alkalinity of the sputa, at the same time the water of the bronchial mucus, and thus the liquidity of the sputa. They constitute a special class called the **saline expectorants.** Sulphur, Iodine, all the Aromatic Oils, Oleo-resins and Balsams are excreted as such, or as their products (along with an increased flow of mucus); and most of these, especially the aromatic substances, have an antiseptic, deodorant and disinfectant effect on the secretion, and on the surface from which they are given off. They may be classed as the **disinfectant expectorants.** The water of the bronchial mucus is increased in almost every instance of increased secretion, but specially by Alkalis, Iodine and Antimony, which thus possess the valuable property of increasing the liquidity of the sputa. Lastly, Acids tend to diminish the amount of water, and thus the total amount of sputum, *i.e.* to "dry up" the secretion. They might be called **anti-expectorants.**

(B) **Antispasmodics.**—These comprise a great variety of measures which have the common effect, directly or indirectly, of relaxing the muscular coat of the bronchi and the diaphragm. They are: (*α*) the various depressants of the respiratory branches of the vagus mentioned above (4), such as heat, Iodides, Alkalis, etc. (*β*) The depressants of the other afferent nerves to the respiratory centre (5), especially warm applications to the chest walls. (*γ*) The depressants of the respiratory centre itself (5)—Alcohol, Ether, Chloroform, Opium, etc. (*δ*) The direct nervo-muscular depressants—bronchial, (4*f*), such as Atropine, Tobacco, Amyl Nitrite, etc.; and parietal (6), Conium, etc. All these substances are distinctly depressant or sedative; and we have (*ε*) still another group of bronchial antispasmodics, which are perhaps the most powerful of all, namely, some of the expectorants, such as Ipecacuanha, Senega and Tobacco, which after momen-

tarily increasing the spasm, cause a rapid and profuse flow of mucus from the bronchial wall, thus relieving the fulness of the vessels, provoking cough, possibly, and inducing expulsion of the cause of the spasm.

(c) **Respiratory sedatives.**—These measures deserve a special name. The depressants of the afferent branches of the vagus to the brain, such as Opium, Ether, Chloroform, etc., not only act as antispasmodics and muscular depressants, *i.e.* prevent bronchial spasm, widen the tubes and arrest cough, but also prevent or relieve pain and other distressing sensations referred to the respiratory organs. However, the most rational kind of pulmonary sedatives, in cases where the cause of the distress can be removed, are the expectorants above enumerated. A combination of the two classes will manifestly answer best in most instances.

III. Pathological Relations.

The disorders and diseases of this system fall readily into two great classes, according as they affect (1) *the respiratory element* (*the red corpuscle*) and *its circulation*, or (2) the *nervo-muscular apparatus*, including the lungs and air-passages, the respiratory centre, and the afferent and efferent channels of conduction. The first class were discussed in Chapters VIII. and X.; the second will now be illustrated.

Circulatory, inflammatory and degenerative changes comprise a large part of the diseases of the respiratory organs, such as bronchitis, pulmonary congestion, pneumonia, emphysema and pleurisy, to which must be added new growths, whilst tuberculosis and syphilis occupy an intermediate position. Whatever their pathological nature, these diseases produce certain well-marked anatomical changes in the parts. The passages may prove to be obstructed, or actually occluded, by swelling of their mucosa, and by various products, such as mucus, pus, blood or *débris*, which may be retained, inspissated, or possibly decomposed, thus irritating the nerves and vessels. Some of the bronchi may be entirely blocked, with collapse or consolidation of the corresponding lobules, and disturbance of the air-pressure (emphysema) and blood-pressure (hyperæmia) in the parts around. Portions of the lungs may be found consolidated by pneumonia or compressed by pleurisy, airless and functionless. Tracts of various size are frequently destroyed by tuberculosis, cancer or gangrene. Hæmorrhage may occur in the alveoli or passages. The right heart frequently proves to be secondarily enlarged, from disturbance of the pulmonic circulation; the viscera congested; and the serous cavities and extremities dropsical.

Whilst many of these anatomical changes are fortunately remediable, others are not so, and the efforts of the practitioner can only be directed to the relief of their effects. Amongst these, disturbances of respiration, spasm, cough, expectoration, vomiting and pain alone require to be noticed here, and that very briefly.

Dyspnœa is a natural effort to increase oxygenation, and is due to stimulation of the respiratory centre in two distinct ways, viz. (1) by the imperfectly arterialised blood circulating within it, and (2) by exaggeration of the impressions reaching it from the air-passages and lungs. Obviously these two sets of causes are usually combined, since such anatomical changes as have been mentioned interfere at the same time with the proper exchange of gases in the lungs, and irritate the pulmonary branches of the vagus. As a rule, dyspnœa is effective and essentially beneficial; but unfortunately, it is attended with distress.

Spasmodic dyspnœa, commonly called "asthma," is referable to sudden intermittent irritation of the vagus or centre by afferent impulses from some excitable surface. Powerful reflex respiratory impulses pass out to the bronchial muscles and diaphragm, the spasms of which interfere with the entrance of air.

Cough is essentially a physiological act, in itself highly beneficial, which may require to be encouraged and increased. Much more often it is excessive and distressing, and demands relief. *Expectoration* also may be considered physiological within certain limits, but will require to be modified therapeutically when the quantity of the sputa is either excessive or deficient, or its quality rendered morbid by inspissation or decomposition. *Vomiting* is closely associated with cough and expectoration, which is not a remarkable circumstance, the two acts and their mechanisms being closely allied, as we saw in Chapter IV.

Pains and sensations of irritation, tickling, necessity to cough, "want of breath," tightness, oppression, suffocation, etc., are always exceedingly distressing; and, as they are among the chief complaints of sufferers from respiratory diseases, they demand relief if it can be afforded.

IV. Natural Prevention and Recovery.

Nature's method of meeting an extraordinary or otherwise morbific influence by *removing* it, is well seen in the respiratory system. Ciliary action, sneezing, cough and expectoration of tenacious mucus are provisions for expelling pathogenetic bodies from the air passages; and although apparently of

out little service in preventing the most serious kinds of lung disease, they must expel infective and other causes of morbid change much more frequently than we suspect, just as they guard the nose and the glottis from mechanically irritant particles. The nasal sinuses, which warm the air of inspiration, serve to prevent dangerous chilling of the lungs.

The second great natural method of relief which is seen at work in this system is *reaction* or *counteraction*. The respiratory muscles respond to obstruction of the passages in bronchitis, or to the loss of respiratory surface in pneumonia, by such an increase of the force and frequency of their contractions as will negative it; and dyspnœa or (better) hyperpnœa is the result. In spite of these dyspnœal efforts, comparative rest of the affected side, or even of a part of it, is secured through the agency of pain in the chest; and rest checks the pathological processes and promotes repair. After a time the muscles become hypertrophied if the obstruction persist, as in chronic bronchitis and chronic pneumonia, the reserve of muscular force and almost unlimited power of hypertrophy sufficiently *compensating* for the diminished size of the air-passages and lungs by increasing permanently the depth and frequency of breathing. Similar provisions are at work in the catarrh, that is, the hyperæmia and secretion, set up in the air-passages or lungs on the entrance of a foreign body. The mucous, serous or even purulent discharges (all evidences of different degrees of reaction) have the effect of counteracting the irritant, of expelling it, and of repairing the damage it may have wrought.

The third natural provision against a morbid influence is the *removal of its effects*, whether the influence itself have been removed or antagonised, or not. Thus excessive secretions or other products of disease, which may in turn cause fresh obstruction of the passages, are removed by cough, expectoration and vomiting; and the venosity of the blood which they cause is dispelled by hyperpnœa. Even spasm of the bronchi probably never causes death, because removed by the carbonic acid which accumulates in the blood in the second stage of asphyxia. Hæmorrhage from the lungs or nose frequently comes to the relief of over-distended veins, and removes the most urgent symptoms.

Vicarious action is yet another method of natural relief, of which abundant advantage is taken in respiratory disease. Extraordinary muscles are called into play in hyperpnœa; the healthy parts of the pulmonary substance take on increased function; the skin and kidneys doubtless become

more active as excretory organs; and the heart maintains the aëration of the blood by increased frequency and force of its contractions.

In these and other ways Nature will frequently afford escape from respiratory disorders and diseases, or relief from them whilst the causes are still at work, by removing or counteracting these and their effects. If Nature fail and disease be established, recovery may still follow artificial treatment, the proper province of which thus is to assist, not to compel, much less to thwart Nature. Even if structural changes have occurred, recovery may be effected by repair, as we see in inflammation of the lungs and pleura.

V. Therapeutics.

The treatment of respiratory disorders, if it is to be thoroughly rational, must be founded upon the considerations given in the four preceding sections. The student will understand that the treatment of the *disease* on which these disorders depend must be conducted at the same time.

Dyspnœa.—The phenomena of *obstructive* dyspnœa, *e.g.* in bronchial affections, indicate the necessity of providing, by every possible means, for increased freedom and force of respiration—of assisting hyperpnœa by admitting as much air as possible into the chest. The air must be pure and mild, that is, abundant, fresh, warm and moist. The muscles of respiration must be free to act upon the chest, and every available muscle of extraordinary respiration must be relieved from other employment and ready to be called into use: the shoulders raised, the chest freed from restraint and weight in front, behind, and especially below (by adopting the sitting posture), the arms capable of being fixed, if necessary, and the stomach and bowels freed from flatulence, which would impede the movements of the diaphragm. The circulation also must be spared by absolute rest and other measures.

Medicinal treatment would then be ordered, the first ends to be secured being either the control of any catarrh on which the dyspnœa depends, or the rapid clearance of the respiratory passages of the products of disease. The former end may be attained rationally by using alkalis; the second end by stimulating the natural provisions for relief, namely *cough and expectoration*, by means of expectorants. The cough must not only be induced or strengthened, but accompanied by a more profuse flow of watery mucus, so as to facilitate discharge of the sputa. Fortunately, most expectorants produce the second effect as well as the first; and we are left free to select our remedy from a consideration of

its concomitant effect upon the circulation, *i.e.* according as a *sedative* or a *stimulant* effect is desired. Cardio-vascular sedatives, such as Antimony, Ipecacuanha, Iodides and Alkalis, or a combination of these, will be preferred as expectorants in the first stage of inflammatory obstruction of the passages (*acute bronchitis*), salines being specially valuable as liquefying the mucus; whilst stimulants, such as Ammonia, Strychnine, Squill and the Aromatic group, will be indicated at a later stage when the heart threatens to fail, or at any period in weak subjects. The Aromatics, such as Camphor, the Balsams of Tolu and Peru, Benzoin, Ammoniacum and Turpentine, also act as disinfectants, if the products have become purulent and tend to decompose. In every instance the value of warm liquid food must be taken advantage of. Oxygen is called for in urgent cases.

Emetics may be employed to empty the respiratory passages when blocked by a comparatively large and solid mass, such as a croupous membrane; to empty dilated bronchial tubes when these and the lung tissue have lost their elasticity from age and debility; and occasionally, when the necessary cough can no longer be induced on account of extreme weakness, and asphyxia is threatening. In the last-named case much danger attends such a depressing method of treatment; and in every instance comparatively mild but efficient emetics must be selected for respiratory purposes, such as Ipecacuanha or Ammonium Carbonate, or Zinc Sulphate if these fail.

Posture is frequently of value in emptying the bronchi, or cavities communicating with them, of pus and other products. The body sometimes may be inverted with success.

If asphyxia occur, artificial respiration must be carried out.

Dyspnœa may also be relieved by the abstraction of blood, or by diversion of it from the thorax into the abdominal vessels, and reduction of its volume, by a free purge, which sometimes affords great relief at the commencement of acute bronchitis. Diaphoretics and diuretics are valuable in similar circumstances. But instead of reducing the volume of blood, or in addition, we may prevent its accumulation in the lungs and right side of the heart by stimulant measures. Thus Ammonium Carbonate not only stimulates the nerves and glands of the bronchial mucosa, liquefies the secretion and strengthens the respiratory centre, but is a powerful cardio-vascular stimulant, aiding the ventricular contractions, emptying the veins and filling the arteries. Other circulatory stimulants which may not possess expectorant action

are so far also indicated in respiratory distress, such as Strychnine hypodermically, applications of Mustard to the chest wall and warm alcoholic drinks.

In dyspnœa from consolidation of the lung in acute pneumonia, *i.e.* from *diminished respiratory area*, the plan of treatment must be considerably modified. Here there is neither lack of air nor lack of blood; only they cannot come into mutual contact. The respiratory rate is greatly accelerated, and the air thus constantly changed; the cardiac rhythm is also accelerated, and the blood thus constantly renewed. The therapeutist appreciates this natural provision, and directs his measures to the support of the powers thus severely taxed: to maintain the strength of the respiratory muscles, and, most anxiously of all, to sustain the heart, by failure of which death is most likely to occur. Whilst, therefore, the strength is spared in every way, food is to be freely given, with Alcohol, Squill, Ammonia, Strychnine hypodermically and Digitalis; the atmosphere maintained as pure and fresh as possible, and Oxygen added to it; and the accompanying fever, which is attended by cardiac depression, steadily combated by suitable measures.

Dyspnœa with spasm is treated on the same principles as other forms of obstructive dyspnœa, including attention to the cause, but the spasmodic element is also considered. By far the most rapid and most powerful antispasmodics are, as we have seen, certain *expectorants*, including Tobacco, Ipecacuanha, etc., which provoke greater spasm, violent cough and profuse watery secretion, and thus instantly clear the passages and relax the respiratory passages. A milder and equally rational class of antispasmodics to be employed in asthma are the direct depressants of the nervo-muscular structures of the bronchi, the chief of which are Belladonna, Hyoscyamus, Stramonium and their Alkaloids, Tobacco and Lobelia, whether in solution or in the form of smoke. Conium is much less useful. Moist warm air or steam may be of some service and the only available remedy. Opium, Chloral Hydrate, Cannabis Indica and Cocaine and other narcotics will frequently relieve spasm, but such powerful respiratory depressants are highly objectionable in threatening asphyxia. Nitrite of Amyl may instantly give relief, but the spasm may as quickly return; Nitre fumes suit some cases. Small doses of Spirit of Ether or Chloroform in solution are frequently most valuable, because so rapidly diffusible; and a mixture of Aromatic Spirit of Ammonia, Spirit of Ether and Aromatics is one of the best combinations for general employment. Paraldehyde is also useful.

Cough has been already referred to as far as it is to be encouraged, for the relief of movable obstruction and dyspnœa. If it be not only ineffectual but harmful, for instance when due to swelling, morbid growth or purely nervous causes, it demands measures for immediate relief. But one cannot insist too strongly on the tendency of young practitioners to abuse remedies of this class, by prescribing them in a routine fashion for every case of cough, irrespective of its cause. Narcotics are powerful depressants of the respiratory centre, as well as of many other organs, including the heart; and, which is of equal consequence, they interfere with the reflexion which originates beneficial cough and increased breathing, and may ultimately aggravate the condition which they temporarily relieve. It is only when the cause of cough cannot be removed that the irritability of the nervo-muscular apparatus may be safely reduced by respiratory sedatives, such as Opium, Chloroform, Ether, Chloral Hydrate, Alcohol or Conium, according to circumstances, whilst warm moist air, warm liquid food, poultices to the chest, and acids or demulcents for the throat may suffice to give relief. Several of these measures can be topically employed by insufflation, inhalation, gargling, or direct application as a spray; and when given internally they are advantageously combined with expectorants, which shall expel any movable irritant from the passages. When all but powerful opiates fail to arrest protracted fits of coughing, as in phthisis, frequent small meals of warm liquid food, night as well as day, or pure alcoholic stimulants are useful, and bodily rest should be insured.

When the sputa are *excessive*, anti-expectorant measures may be demanded, and will consist in a fresh bracing atmosphere, dry simple food, the avoidance of alcohol, and the exhibition of Acids, Bitters, Strychnine, and probably Iron internally.

Hæmorrhage from the respiratory organs must be treated on general principles. Rest must be secured not only by bodily quiet, but by the reduction of the movements of the lungs to a minimum.

Pain and the other forms of *distress* in connection with this system are easily arrested by direct respiratory sedatives, such as Opium, but as we have seen, not without considerable risk. Therefore, whilst Morphine hypodermically is often urgently demanded, *e.g.* in pleurisy, great discrimination must be exercised in having recourse to this remedy, and the routine use of it is to be deprecated. Indirect measures,

including the removal of the cause of distress, and external applications to the chest are usually sufficient.

In all classes of chronic disease of the respiratory organs use is made of climate, and of the invaluable benefits of fresh air, proper diet and well-ordered digestion. In some of them respiratory (that is, bodily) rest is called for; in others of them respiratory exercises are equally important.

CHAPTER XII.

THE NERVOUS SYSTEM.

THE therapeutical relations of the nervous system are as extensive as those of the whole body itself. Pain, for example, is constantly associated with local disease, and many of the most distressing diseases of the viscera are disturbances of nervous mechanism. Here we must confine ourselves chiefly to the therapeutical relations of the higher nervous centres, representing sensation, consciousness and voluntary motion, especially to the means by which we may relieve pain in general, produce unconsciousness, and induce sleep. The student must also clearly understand that we are approaching the therapeutics of the nervous system from the *physiological* side, *i.e.* the treatment of disorders, only. The treatment of the *pathological* processes, such as hæmorrhage, inflammation, degeneration, new growths and syphilis, which constitute these diseases and cause these disorders, is another and even more important part of the management of this class of cases, and one which falls under other heads.

I. PHYSIOLOGICAL RELATIONS.

Nervous tissue is a kind of protoplasm with highly specialised properties, which may be resolved into the one great property of displaying or discharging energy when brought into contact with certain influences. We name this property *excitability*, the influence which calls it forth *a stimulus*, the act of calling it forth *stimulation*. If the effect be the display of an ordinary amount of energy or more, we speak of the influence as a *stimulant*, and of the act or result as *stimulation*. If the effect of excitation be the display of less energy than ordinary, we say there has been *depression*—that the influence is a *depressant*. Discussion is still going on as to the nature of excitability, stimulation and depression, but the points just indicated are clear enough for our present purpose.

The nervous system is built up of a number of *centres*, which are connected with an *excitable surface* or structure on the one side, and with the *organs of force* on the other side. An *impression* made on the excitable surface by a stimulus produces a molecular change in the associated nerve terminations; this is conducted by an *afferent* nerve through a peripheral ganglion to the centres; effects there some change upon the protoplasm; and either remains as potential energy,

or flows out again through *efferent* tracts and nerves as an *impulse* to the organs of force—the muscles, glands, vessels, etc. This process is spoken of as *reflex action.* Nervous substance is, however, not simply irritable, or capable of being brought into action by an impression from without. It is *automatic* as well as reflexive. The highest centres are the seats of the emotions, of the intellect, of the will, and of consciousness, in which actions originate and modify the impulses flowing out of the reflex centres, by means of connecting fibres or tracts. The highest centres are in the convolutions; the simpler automatic and reflex centres in the basal ganglia, cerebellum, medulla and cord; and the whole constitutes a series of successive centres joined to each other by tracts which conduct, associate and co-ordinate the impulses. Their outlying or peripheral ganglia, the *sympathetic*, are chiefly automatic in their action. The nervous supply of the viscera and vessels is referred to in other chapters, and all that need be stated at present is that most of them are governed by centres in the medulla and cord, an arrangement which is partly reflex; that they are constantly influenced by impressions reaching them from all sides; that the efferent nerves between the centres and the viscera are intimately connected with the sympathetic chain; and that the viscera have intrinsic ganglia, acting automatically, but controlled by the higher centres.

Now we find, when we come to consider the actions of drugs and other remedies on the nervous system, that certain of them (and the same drugs in different stages of their actions) affect one centre, some another; some peripheral and afferent parts, others efferent or motor parts; that some drugs affect the lower centres only, some the centres of emotion and intelligence only, some the nervous mechanisms of the different viscera; and that others, again, interfere chiefly with co-ordinating mechanisms. Let us analyse these actions.

Sensation.—Sensation is a cerebral state, referable to an impression or impulse received through an afferent nerve. This generally originates at the periphery, more rarely in the afferent nerve or tract, but is in every case referred to the periphery. In this way an *impression* (peripheral) becomes a *sensation* (cerebral), and a sensation in turn may or may not travel onwards into a still higher part of the cerebrum, where it becomes a *perception*, a part of *consciousness*, a mental act. Of the various perceptions, common sensibility alone demands special notice here. The tissues and organs in health are sensitive, but not the seat of actual sensations. Very slight disturbance, however, is sufficient to arouse

perception or consciousness of the condition of the organs, of which pain is an instance, and we therefore assume the constant existence of a quiescent sense called *common* or *general sensibility*.

Motion.—All movement may be said to originate as an *impulse* in a nervous centre, whence it is conveyed to muscles or muscular organs by *efferent* or motor nerves. Thus an impulse arising in the automatic action of the cerebral cells travels from the higher to the lower centres; here it joins the reflex impulse, proceeding by reflexion from these centres; and the mixed (modified) impulse courses through the motor nerves to a special *terminal apparatus*, say in a muscle, by which the motor nerve is brought into relation with the organ. Just as a perception in the cerebrum may be referable to a condition of any part of the afferent or sensory side of the nervous system, so muscular contraction may be produced by stimulation of any part of the efferent or motor side, from the convolutions to the muscle itself; and, which is of special interest to the therapeutist, it frequently originates, wholly or in part, in stimulation of some part of the sensory side, reflected through the centres.

Consciousness.—This is a purely mental state, partly consisting of perceptions, and partly inseparably associated with the emotions, the intellect and the will. Consciousness depends on the perfectness of the whole sensory apparatus, but from a practical point of view it may be considered to reside in the cerebral part of the same, *i.e.* in the convolutions, where it is readily reached by the therapeutist.

Sleep.—We cannot account perfectly for natural sleep, but we are probably right in associating it with diminished metabolism of grey matter, whether due to deficient blood supply, to altered quality of blood, to the presence in it of soporific substances produced during waking hours, or to molecular inactivity of the tissues following fatigue. Sleep bears a definite relation to work, food and the time of the day, and brings rest and refreshment to the system.

In both the grey and the white matter of the central nervous system the proper nerve structures are supported by the neuroglia, which, however, is neither developmentally nor chemically a true connective tissue, but of epiblastic origin.

II. Pharmacodynamics.

When we come to consider how far the nervous system is under our influence, we enter upon a field of enormous proportions, of which we can make but a brief survey.

1. *Sensation.*—We have a remarkable power over both

common sensibility and the special senses, increasing or diminishing their activity at our pleasure, by means respectively of *local stimulants* and *local anæsthetics.*

a. **Local stimulants.**—This name is given to a great and mixed group of agents, which increase common sensibility or even excite *pain.* The majority of them act directly upon the *nerve fibrils* in the tissues, such as extreme heat, extreme cold (for a time), faradic electricity, and many drugs, including: Iodine and Bromine; Alcohol, Ether and Chloroform, when the vapour is confined; Carbolic Acid and Creosote; volatile oils, *e.g.* Turpentine, Cajuput, Menthol, Thymol; acrid essential oils, *e.g.* Mustard and Mezereon; and Cantharides in the first stage. Mineral Acids and Ammonia, and metallic salts, such as those of Silver, Lead, Zinc, Antimony, Mercury, Arsenic and Copper, also stimulate sensory nerves and cause severe pain, but only when supplied in sufficient strength to interfere markedly with the vessels and protoplasm of the part as astringents or caustics. Possibly some local stimulants act primarily upon the vessels, and many of them no doubt excite the circulation as well as the nerves.

It must be carefully noted that the effect of local irritation on the sensory apparatus is really a *central* one. The sensation of pain, although it may be referred to the periphery, is a cerebral state. Local stimulants, therefore, afford us means of rousing the highest centres. What is even more important therapeutically, the whole of the impression conveyed from the irritated spot does not become converted into a painful sensation or act of consciousness. A portion of it, whilst traversing the nerves, and the grey matter of the spinal and medullary centres *en route*, disturbs these and causes reflex impulses, which rouse the muscles and viscera. In this way sensory and especially *painful* impressions are powerful and readily available means of stimulating not only consciousness, but the cardiac, vaso-motor and respiratory centres, and through them, as well as reflexly, the great viscera themselves. Thus the cold douche produces a sensation of cold referred to the part, rouses consciousness, and so excites the respiratory centre as to cause the gasping movements of breathing familiar in the circumstances. Massage is a valuable cerebral stimulant. In other words, *local stimulants may become powerful general stimulants.*

b. **Local anæsthetics.**—Pursuing an exactly opposite line of action, we can readily diminish the excitability of the origins of nerves until their power of receiving impressions is lost; and thus arrest sensations by preventing the very con-

tact of the influence with the nervous system. The measures which have this effect are called **local anæsthetics** (*ἀν, without*, and *ἀίσθησις, sensibility*), or, if pain be relieved, **local anodynes** (*ἀν, without*, and *ὀδύνη, pain*) or **analgesics** (*ἀν, without*, and *ἄλγος, pain*), or simply **local sedatives**. Some of these agents directly depress the end-organs and nerve fibrils, such as Belladonna, Aconite, Cocaine and Opium ; also Ether, Alcohol, Chloroform, Carbolic Acid, Volatile Oils and Cantharides, when their application is prolonged. Moderate cold, especially such as is induced by evaporation, is decidedly anæsthetic ; and Ethyl Chloride, Ether, Spirits, Acetic Acid, Water and various Saline solutions, *e.g.* of Ammonium Chloride, possess this property. Prolonged or extreme cold directly reduces the functions of the nerves, causing first numbness, and then absolute anæsthesia. Warmth reduces, and extreme heat destroys, the excitability of the sensory end-organs. Other anodynes act partly or wholly through the vessels. Thus moderate heat relieves pain partly by dilating and relaxing the bloodvessels, and by increasing the blood-supply, the osmosis, and the migration of corpuscles in the tissues—an effect which is assisted by moisture, as familiarly seen in fomentations. Cold partly acts by reducing excessive blood-supply. Electrical currents of high frequency and tension, as well as the galvanic current, remove pain very quickly by influencing the nerves, muscles, vessels, and even the metabolism of the part, the anode being applied to the nerve. Gentle massage is also a local sedative.

The influence of local anæsthetics and anodynes is not confined to the sensorium. With the arrest of sensation, the whole brain passes into a state of rest, and sleep readily occurs. The in-travelling impressions being reduced in strength, the ganglia and spinal and medullary centres through which they pass, or into which they had previously radiated, are no longer excited, and the actions of the organs, such as the lungs and heart, become more automatic, and, as a rule, but not invariably, more quiet. Thus, as with local irritants, we possess in local anæsthetics and anodynes a powerful means of influencing the functions of the highest centres, the visceral centres, and the viscera themselves. In other words, *local sedatives may become powerful general sedatives.*

c. All these measures act upon the peripheral structures. The *trunks* of the afferent nerves may also be affected so as to interfere with the conduction of impressions. Opium and possibly other drugs, heat and cold, electricity, properly

regulated pressure, and section or stretching of the nerves are different means of reducing their conductivity and thus removing sensibility or at least pain.

d. The sensitive and perceptive *centres* in the cerebrum may be the seat of action of anæsthetics. Amongst the substances producing this effect are Opium, Chloral Hydrate, Chloroform, Ether and their allies, Nitrous Oxide Gas, and Cannabis Indica, consciousness as a whole being affected by these measures, which are called **general anæsthetics, general anodynes,** or **narcotics**—a series of titles which will be noticed presently. Lastly, it will be observed that certain drugs, such as Opium, arrest the afferent impressions *at every point*—at their formation, in the course of their conduction, and where they impinge upon the sensorium; that is, they act upon the sensory tract from the one extremity to the other.

e. The *special senses* also can be directly influenced by various measures, including drugs. Local anæsthetics reduce the keenness of the sense of touch. Deafness and subjective noises are produced by Quinine, Salicylic Acid and Alcohol. Santonin causes green vision. Taste is excited by a variety of influences which we have already studied; depressed or peculiarly disturbed by Aconite and other alkaloids.

2. *Motion.*—Our command of the motor side of the nervous system is greater than our influence over sensation, for the reason that motor parts can be acted on not only directly, but also reflexly through sensory parts, as we have just seen—local irritants exciting muscular movements, and local depressants arresting them.

a. Motor stimulants are specially interesting, as different drugs act on different parts of the motor apparatus from the cerebrum to the muscles. Alcohol, in moderate doses, increases the activity of the "motor" *convolutions*, and so probably do Chloroform and Ether for a very short time. The *medulla*, as the centre of the respiratory movements, is excited by Strychnine, Ammonia, Belladonna, and by small doses of Alcohol, Ether and Chloroform. The *anterior cornua* of the cord (probably in association with the posterior cornua) are powerfully stimulated by Strychnine, convulsions being readily induced. Stimulation of the *motor nerve trunks* can be used to excite the muscles by means of faradic electricity.

Our most valuable motor stimulants, however, are applied to the *terminations* of the nerves, the *terminal apparatus*, and the *muscles* themselves, in the form of **local motor stimulants.** Strychnine acts also in this way. Electricity is used for this purpose, as the faradic current, occasionally as

the galvanic current. Passive movements of the limbs, rubbing, shampooing (massage) and douching, by rousing the local circulation and metabolism, are also means of preserving or increasing muscular nutrition and activity.

b. Motor depressants are a parallel series of agents. The motor convolutions are disturbed, depressed and finally completely "paralysed" by large doses of Alcohol, Chloroform and Ether, which entirely arrest all voluntary movements, possibly by acting on the chromatoplasm. The motor functions of the *medulla* are so powerfully depressed by Opium, Chloral Hydrate, Aconite, Conium, Physostigma and large doses of Alcohol and Chloroform, that death from poisoning by these substances occurs in this way. The *anterior cornua* of the cord are depressed by Physostigma and other less powerful drugs, which cause paralysis of the limbs through this channel. The same effect is produced by Conium and other substances, through depression of the *motor nerves*, not of the cord. The *motor nerve-endings* are remarkably under the influence of Belladonna; more, however, those of the involuntary muscles, with which we are not at present concerned. Galvanism is the most powerful local depressant of muscular activity, and is our ordinary means of producing this effect directly.

c. The *co-ordination of movements* is peculiarly interfered with by certain drugs, at any rate by Alcohol, which in considerable doses produces staggering gait, disturbance of the ocular muscles with double vision, thickness of speech, and awkwardness of the manual movements.

3. *Consciousness.*—From the very exalted position which it occupies in the system, consciousness is peculiarly amenable to a variety of influences at our command.

a. It can be *roused* by powerful, especially painful, impressions: for instance, the cold bath or douche; heat, or hot applications such as mustard, to the surface; loud sounds, or powerful odours. Besides these, many drugs directly excite the brain: the **cerebral stimulants** and **deliriants**, such as Caffeine, Camphor, Alcohol and Chloroform in the first stage; Opium, Chloral Hydrate and Cannabis Indica, in some individuals; Belladonna and its allies; Salicylic Acid; Nitrous Oxide very briefly, etc.

The mental faculties are readily *disordered* by many of the measures which rouse the consciousness. The result is laughing, crying, brilliancy of the imagination, increase of the appetites, confusion of the intellect, loss of control of the will, and possibly even delirium in its many forms. Alcohol, Opium, Cannabis Indica, Chloral Hydrate, Chloroform, Cam-

phor and Belladonna are specially active in producing these effects, which are seldom or never desired by the therapeutist for their own sake.

b. Equally valuable are our means of *reducing* consciousness, or *removing* it, and thus producing general anæsthesia, which, in appearance at least, closely resembles sleep, and is associated with suspension of all the other mental faculties. This effect may be secured by temporarily arresting the functions of the convolutions by means of drugs that *directly depress the nervous tissue of the convolutions* by a bio-chemical action on the chromatoplasm of the cells, or by a bio-physical action on the dendrites. Such are Chloroform, Ether, Ethyl Chloride, Alcohol in large doses, Chloral Hydrate and Opium. The Bromides, Caffeine and Zinc are valuable **cerebral depressants,** as they diminish reflex excitability and thus promote rest of the nervous centres. Beyond these, a number of powerful substances, such as Aconite and other vegetable and mineral poisons, produce a condition of coma with unconsciousness. The question arises: Which of the many active substances that possess this power are convenient and suitable for use? Careful observation has taught us that the *order of involvement of the various parts of the nervous system* by these substances—the line of march of their phenomena—differs widely with the different drugs. With some of them, such as Ether and Chloroform, the very first phenomenon is disturbance of the convolutions; and it is not until consciousness has been completely removed, that any serious depression of the medulla and its vital functions occurs. With others, for example, Opium and Chloral Hydrate, the cerebrum and medulla appear to be simultaneously and equally involved; and before consciousness has been completely removed, the centres of respiration and circulation in the medulla may be dangerously depressed. A third set of nervous depressants have hopelessly paralysed the medulla before consciousness is much disturbed; such are Aconite and the irritant poisons. In selecting for use a drug which will remove consciousness, we entirely reject the third set. The first set, with Ether and Chloroform as their types, we retain as our **general anæsthetics**; the second set, including chiefly Opium and Chloral Hydrate, are used in special circumstances, and are generally called **narcotics** (*νάρκη*, a deep sleep), or, as we have already seen, *anodynes*, pain-destroyers.

The action of **narcotics** is very complex, extending from the one extremity of the sensory side of the nervous system to the other, influencing also its motor side, and disturbing the sensory, motor and metabolic functions of most of the

viscera. In a person under the full influence of Opium an impression can be made only with difficulty upon the peripheral nerves, or on the organs of sense; the afferent impulse is slowly and imperfectly conducted; and it is imperfectly perceived in the cerebrum. Thus cut off from all but the most powerful external impressions, and itself reduced in activity, the cerebrum is practically in the condition of deep sleep, characterised by unconsciousness. A fact of much greater importance, since unconsciousness is not of itself serious, however prolonged, is that it is accompanied by great depression of the medulla, that is, of the respiration and circulation, which, although sometimes to be turned to useful account, may readily prove injurious or even highly dangerous. We thus possess in narcotics powerful means (1) of arresting perception, (2) of inducing sleep, and (3) of soothing the great vital functions. These may be of the greatest therapeutical service if employed correctly.

4. *Sleep.*—We have many means of promoting or producing sleep, which we call **hypnotics** (ὕπνος, sleep), or less properly "narcotics." Thus we may be able to secure mental calm, or the absence of noise and light, and to prevent or relieve pain or other disturbing impressions, such as attend indigestion, heart disease, cough and gout. Along with these *indirect hypnotic* measures, we may employ *direct hypnotics*, which act on the convolutions, either through the circulation or immediately upon the cells, in either way reducing nervous excitability. Amongst medicinal hypnotics the purest are perhaps the Bromides, which appear to bring the brain into a condition that favours the advent of natural sleep, rather than to induce it artificially, if any such distinction can be drawn. Artificial sleep is readily induced by Trional, Sulphonal, Veronal, Chloralamide, Paraldehyde, Chloral Hydrate and Opium, as well as by general anæsthetics, all of which may be used for this purpose.

III. Pathological Relations.

We will now briefly consider some of the most common and typical disturbances of the nervous system. The structural diseases of this system are of great variety, including morbid states of the vessels, syphilis, degenerations, etc., but it is only the principal disorders to which they give rise that will be noticed here for the purpose of illustrating the applications of the measures just discussed.

1. *Disturbances of Sensation: Pain.*—Pain is a familiar and distinct disorder of sensation of a peculiarly distressing kind. As an expression of disease, whatever the tissue

affected, pain always originates in some nervous structure between and including the sentient periphery and the convolutions, but in every instance it is referred to the periphery. When pain is severe, it is accompanied by certain other phenomena, such as mental depression and restlessness, sleeplessness, weakening of the heart, indigestion and other visceral disturbances. These may be in part effects of the morbid condition on which the pain also depends, but it is to be observed that pain is in itself a powerful depressant of the centres and viscera, just like local depressants of a pharmacodynamical nature.

2. *Paralysis.*—Loss of power may be taken as an instructive illustration of motor disturbance. Comparably with pain, paralysis depends on injury or disease, of whatever nature, in some part of the motor side of the nervous system—the convolutions, basal ganglia, medulla, lateral column and other motor tracts, anterior cornu, the anterior root of the spinal nerve, the nerve trunk and branches, or the terminal motor apparatus in the muscle; occasionally it is distinctly a reflex effect of sensory disturbance; but the paralysis is always seen in the muscle. No class of disease teaches us more clearly the dependence of rational therapeutics upon an accurate knowledge of the anatomy, physiology and pathology of the parts affected.

3. Side by side with pain and paralysis, respectively, there are to be ranged many allied conditions. Thus, allied to pain, and depending like it on disturbance of some part of the *sensory* tract, are the sensations of numbness, coldness, excessive sensibility to touch (hyperæsthesia), excessive sensibility to painful impressions, such as pin-prick (hyperalgesia), and the various disturbances of the special senses; loss of the sense of touch (anæsthesia), loss of the sense of pain (analgesia), and alteration or loss of the organic sensations relating to the stomach, bowels, heart, bladder, etc. In the same way we place beside paralysis other motor disturbances, whether in the form of increased muscular movements—chorea (St. Vitus's dance), tremors, spasms, convulsions, or disturbed movements of the viscera, as of the heart, intestines, uterus, vascular walls, etc.; and we say that they may be due to disease of any part of the motor tract from the one extremity to the other, or of some part of the sensory area of the nervous system by reflection through the centres. Reflex spasms, convulsions, and visceral disorders are especially common. Disorders and diseases of other parts of the nervous system, such as the posterior-root ganglia and associated fibres, the cerebellum and the semicircular canals, give rise

to inco-ordination of the muscular impulses, and consequent disturbance of gait, staggering and giddiness.

4. Disturbances of *consciousness*, and of the other higher faculties of the nervous system, include unconsciousness or insensibility, delirium or excitement, neuroses, neurasthenia in many forms, and the great class of "diseases of the mind" constituting insanity. Unconsciousness may be the result of injuries to the head; of interference with the supply of blood to the brain, familiarly seen in fainting; of interference with the supply of air to the brain, as in asphyxia; of renal disease; of hyperpyrexia, or of poisons, such as toxins, alcohol and opium. To these causes we may add structural diseases of the brain, and indeed most diseases just before death. Delirium and other forms of excitement are phenomena of many diseases, and of the action of a variety of poisons, and must be regarded as associated, both as effects and causes, with excessive nervous metabolism, leading rapidly to exhaustion.

5. *Sleep* is most commonly *deficient* or *absent* when it calls for treatment; very frequently disturbed; sometimes excessive. Pain is the common cause of insomnia, but sleep may be prevented or broken by cerebral exhaustion (? vascular paralysis) from overwork, by mental anxiety or distress, by oppressed or breathless feelings in the chest, by dyspeptic and gouty troubles, and by other distressing sensations, such as irritability of the bladder, spasms of the muscles, and itching of the skin. Sometimes sleeplessness appears to be idiopathic, *i.e.* a disorder *per se*. Excessive *sleepiness*, or continual tendency to sleep, is a result of the retention and circulation in the system of urea or allied products which have not been sufficiently excreted by diseased kidneys; and drowsiness, to a less degree, is a frequent symptom of anæmia, or of disturbed metabolism in the liver, as we saw in the seventh and eighth chapters. Certain articles of diet, especially alcohol in the form of beer, produce the same effect.

IV. Natural Prevention and Recovery.

As the nervous system is the most impressionable of all the tissues, so it seems to possess most quickly and most perfectly the power of recovery from conditions of disorder when the causes of these are removed. Thus, pain may instantly disappear upon a slight change of temperature, on the application of a weak electrical current, with the alteration of the chemical reaction of the part, or in consequence of the contact with it of a minute quantity of some drug—any of which

means will have sufficiently restored its normal condition, or counteracted the abnormal state which gave rise to the distress. In no department of pathology, therefore, is the indication clearer, and encouragement greater, to step in and assist Nature by pharmacodynamical measures. Unfortunately, here, as elsewhere, there are certain *limits* to treatment. The functional disorders to which we have alluded, such as paralysis, spasm, pain, anæsthesia, and disturbances of consciousness and of the mind are too often but phenomena or symptoms of the many structural diseases of the nervous system that may indeed be repaired, but usually at the cost of local disablement, unless in the peripheral nerve fibres, where spontaneous regeneration is remarkably ready and complete. Scarcely less hopeless is the prospect of curing certain diseases of the nervous system that have no known anatomical cause, such as epilepsy and hysteria. But even in both these classes of cases, many of the most urgent kinds of distress and derangement, and the severity and frequency of others, can be mitigated with the measures which have just been reviewed, as we shall now attempt to show.

V. Therapeutics.

In drawing a rational conclusion from what we have studied under the four preceding heads, we approach, as we proposed, the consideration of the therapeutics of the nervous system chiefly from the point of view of disorders.

1. *Disturbances of Sensation: Pain, and the use of Anodynes.*—Our review of the physiological and pathological relations of pain leads us to its rational treatment. We must discover, first, its morbid cause, and secondly, its exact physiological significance, and apply our measures accordingly.

The scientific use of anodynes, as we have already suggested, is founded upon correct diagnosis. It will frequently be found that when the cause is known, pain can be removed without the employment of any nervine remedy, and in every instance this treatment should be entertained or attempted. An abscess will be relieved with the knife, headache by purgation, syphilitic periostitis with Iodides, acute rheumatism with Salicylates. We thus discover a great group of measures which, whilst they are not anæsthetics, are *indirect anodynes*, because they attack the pathological cause of the pain, and do not immediately act upon nervous tissue. *For practical purposes*, anodynes may be classified into (1) *indirect anodynes;* (2) *direct anodynes that act on the peripheral nerves only;* and (3) *direct anodynes that act on the centres*

as well as the periphery. In many instances these may be combined.

a. Indirect anodynes are necessarily a heterogeneous group, and include surgical operations of every kind, which are amongst the readiest and most radical of all, *e.g.* opening abscesses; simple physical protectives, such as ointments and oils in burns; poultices and warm fomentations, and cold in various forms.

Local irritants, such as mustard and blistering agents, which cause much pain at first, may become local anodynes by producing an effect which is called *counter-irritation.* We shall discuss fully this class of remedies in Chapter XV., but we may for the present refer their action to exhaustion of the irritability and conductivity of the local nerves, to dilatation of the vessels and relief of anæmia, and to some influence on the nervous centres corresponding to the affected part. Another natural group of powerful local anodynes, which are chiefly indirect but partly also direct in their action, consists of the essential oils, such as Turpentine, Camphor, and the Oils of Cloves, Mint, etc. These have a complex action: they destroy the organisms of disease by virtue of being antiseptic; they dilate the vessels, causing redness and heat; and they depress the peripheral nerves after temporary pain. Certain allied artificial products possess a similar indirect and direct anodyne power, *e.g.* Carbolic Acid and Creosote. Besides these *local* indirect anodynes, we possess an unlimited number which act *generally;* as many, indeed, as the remediable causes of pain. Thus, neuralgia and headache may be relieved, in different circumstances, by any of the local measures just enumerated, or by such diverse general remedies as purgatives, Alkalis, Quinine, Iron, Arsenic, Iodides, Alcohol, and correction of errors of visual refraction, quite independently of the direct anodynes which we may consider it necessary to apply.

b. Local anodynes.—When treatment directed to the cause of the pain fails or is insufficient, we must attempt to reduce the irritability of the nerves by local means. Direct *local anodynes* now may be rationally employed. Thus in neuralgia, constitutional treatment is combined with the application of a local anodyne sufficiently powerful to interfere with the reception and conduction of painful impressions. We employ Aconite, Belladonna, Opium, Cocaine, the vapour of Chloroform, Alcohol or Ether, the Volatile Oils, Carbolic Acid, Creosote, heat (which often must be extreme), extreme cold, the continuous current, currents of high frequency and high tension applied locally, or local nervous stimulants such as

massage. Most of the drugs mentioned are applied in the form of liniments, lotions or ointments. Morphine may be administered by the endermic or hypodermic methods, the latter being by far the most valuable of all anodyne measures, from the readiness with which it can be given, and the rapidity and completeness of its action. Eucaine (2), with Sodium Chloride (8), and Sterilised Water (1,000) is given by "infiltration," that is, by injection into the deeper layers of the skin.

c. General anodynes.—When pain is very severe, sleep impossible, and the whole system distressed and disordered, direct general anodynes are demanded. The most useful is Opium or Morphine, which may be given in a great variety of forms, and by several channels, the readiest and most powerful of all being the hypodermic method. Chloral Hydrate, Butyl-Chloral Hydrate, Phenazone, Acetanilide and Cannabis Indica are also used, but are greatly inferior to Opium. The narcotic or hypnotic effect of these anodynes is taken advantage of, as a rule, by prescribing them at the usual hour of sleep.

But if pain is unbearable, and if relief has to be not only complete but instant, even these powerful anodynes may be unavailing. In such cases *general anæsthetics* must be employed: the patient must be put under the influence of Chloroform or Ether. Such are the pains of labour, or of the passage of calculus, the pain attending the reduction of a dislocation or a severe surgical operation. Consciousness is quickly abolished, kept in abeyance, and allowed to return when the cause of the pain has ceased. The necessity for such powerful remedies as these will impress on the student the importance of sparing and supporting the nervous system and the viscera, which are reflexly depressed along with it, in every case of pain. Food and stimulants are, as a rule, urgently indicated in protracted pain.

2. *Loss of Common Sensibility.*—Neither this nor the allied condition of loss of touch (*anæsthesia*) often calls for direct treatment, and the large number of nerve-irritants which we possess in the Acids, Metallic Salts, Mustard, etc., are seldom used for this purpose. Pyrethrum is sometimes given in anæsthesia of the mouth.

3. *Paralysis.*—The rational treatment of paralysis will depend entirely on its nature, and the seat of its cause; and this, as in the case of pain, must be ascertained as accurately as possible. If the lesion be cerebral, general remedies must be directed to relieve the pathological state, such as Mercury in syphilis, cardiac measures in vascular rupture, and so on.

Rest of the mind, *e.g.* by Bromides, will be all important. There is no indication, as a rule, to increase the activity of the damaged centres, except by the use of the will after a time; on the contrary, all cerebral stimulants, such as alcohol, are better avoided. In paralysis from disease of the cord, the same general system of treatment is to be followed, but Strychnine may be tried as a direct stimulant of the affected part, sometimes with success. In paralysis due to injury or disease of the nerve trunks or peripheral nerves, the cause must be carefully searched for and removed if possible, such as alcoholism or tumours. The local injection of Strychnine appears to benefit some cases. In every kind of paralysis, local treatment must be carried on along with general, and consists chiefly in exercise of the terminal nerve-fibres and muscles with electricity, massage and passive movements, with the view of maintaining the local circulation and nutrition until the centres, tracts or nerves may have been restored.

4. *Excessive Motor Activity*—in the form of spasm, tremors and convulsions—being generally due to peripheral irritation reflected through the centres, is rationally treated by removal of the cause. The convulsions of children, for instance, are generally to be treated with stomachics, purgatives and anthelmintics; the spasms of adults with carminatives. But in many cases it may be necessary also to employ remedies which depress the reflective centres, such as the Bromides and Opium. When the cerebrum is believed to be the seat of disorder or disease attended by these symptoms, *e.g.* epilepsy, the Bromides are of great service; whilst tetanus, hydrophobia, and other spasmodic diseases with better defined structural changes in the cord and medulla, may be treated rationally with Physostigma and Chloral Hydrate. It cannot be said, however, that much success rewards such treatment. When the spasm appears to be due to purely local causes, Belladonna and Conium are often of use, *e.g.* in chordee, strangury, spasmodic asthma and laryngismus. The continuous battery current, the sinusoidal current and counter-irritants relieve painful spasm of the voluntary muscles, and so does gentle massage. Lastly, Opium again is a most powerful anti-spasmodic for general use, but one not always desirable.

5. *Consciousness* may be said to demand temporary *removal*, in anticipation of the excessive pain and anxiety attending operations. The general anæsthetics in common use are Nitrous Oxide Gas, Ether and Chloroform, the selection and use of which are fully described under their special therapeutics. Conditions of *excitement*, such as delirium

and mania, are to be met by two sets of remedies, which must always be combined—viz., first, cerebral sedatives, such as Opium, Chloral Hydrate, Hyoscyamus (particularly Hyoscine), Bromides, and, if necessary, Chloroform; and secondly, general nutrients and stimulants, chiefly in the form of abundant food, and possibly a certain amount of alcohol. Judicious moral treatment and mental and bodily rest or pleasing change are also indispensable in these disorders as well as in the many neuroses.

6. *Loss of consciousness* appears to require and receive treatment in cases of fainting, drowning, injuries to the head, etc., but the great centres of respiration and circulation are the real objects of our anxiety, for they have been depressed along with the convolutions, and their activity must be maintained if life is to be preserved. Restorative measures include the re-establishment of the general and cerebral circulation by the recumbent posture (possibly inversion) and cardiac stimulants, and of respiration by artificial chest movements and abundance of fresh air. Local nervous irritants such as cold affusion, flagellation, or mustard applied to sensitive parts, powerful odours and Ammonia must each or all be employed.

7. *Disorders of Sleep* will be rationally treated by pursuing the course suggested by our previous considerations. *Insomnia* is met with the many hypnotics now at our disposal. In every instance full advantage must be taken of the indirect group. Bromides are indicated when the cerebral circulation is excited by overwork; and Chloral Hydrate may be combined with it. When pain is present Opium only will induce sleep, apart from specific remedies like Iodides or Salicylates. When there is much mental distress Opium is again necessary, and Alcohol at bedtime may be invaluable. In every instance the time of administration of hypnotics must be carefully ordered. Further, it must never be forgotten that the narcotics, including Opium, Morphine and Chloral Hydrate, are all powerful depressants of the respiration, circulation and excretions, and, unless ordered with judgment, may produce disastrous results whilst they afford the temporary advantage of sleep.

CHAPTER XIII.

THE KIDNEYS.

THE position which the kidneys occupy in the circle of the great physiological systems gives a special character to their diseases, and to the actions and uses of remedies in connection with them. The series of vital processes which commences with the admission of food, air, and medicines ends chiefly with the excretion of urine. Digestion, assimilation, sanguification, metabolism, circulation and respiration, all, therefore, affect the activity of the kidneys. This result is chiefly due to the fact that the kidneys do not themselves form the urea, uric acid, pigments, salts and water which constitute the bulk of the urine: these bodies reach them by the blood, and have but to be swept from the circulation. This dependent position of the kidneys is of great interest to the practical therapeutist. Clinically, the condition of the urine is a key to the manner in which the various viscera are discharging their functions; pathologically, we often find in other organs the cause of renal disease; and pharmacologically, we discover that if we wish to affect the composition of the urine and the activity of the kidneys, we must, in many cases, direct our measures to the digestive organs, the heart and the vessels. Conversely, the kidneys make their influence felt backwards upon the other organs. Disturbance of the renal function soon tells upon the blood and viscera. We saw this under the heads of the liver and metabolism, and noted how quickly the retention of waste products checks functional activity, like ashes choking a fire. An equally striking relation exists between the kidneys and the organs of circulation. Thus the practitioner, adopting the inverse order of investigation from before, estimates the condition of the kidneys by the pulse, bowels and appetite; the pathologist finds in the enlarged heart and ruptured vessels of the brain the outcome of disease of the renal glomeruli; and the pharmacologist relieves the blood-pressure or the liver by measures directed to the kidneys. These preliminary considerations will prepare us for the systematic discussion of this complex subject.

I. PHYSIOLOGICAL RELATIONS.

The source of the urine is believed to be certainly double. The bulk of the *water* and salts are excreted from the Malpighian glomerulus into the capsule, in part at least by the blood-pressure within the former. The excreting force is determined: (1) by the pressure of the blood entering the glomerulus by the afferent vessel, and (2) by the resistance to its flow through the smaller efferent vessel; whilst the freedom of filtration depends upon the fact that the uriniferous tubules have a free outlet, and thus present but little obstruction to the entry of water into their channel. A selective influence is also exercised by the capsular epithelium.

The size of the renal vessels is regulated by vaso-motor and vaso-dilator nerves, coming from the renal plexus, which derive their renal fibres from the medulla oblongata. The spot in the fourth ventricle which thus presides over the vessels of the kidney is a *centre*, *i.e.* it receives impressions through afferent fibres, and sends impulses through efferent fibres to the kidneys. In this way powerful emotions disturb the flow of urine, and the temperature of the surface of the body affects the amount of urine secreted, in part at least reflexly.

The *solid constituents* of the urine—urea, urates and their allies, and some of the salts, dissolved of course in a small quantity of water—are believed to be separated from the blood by the cells of the convoluted tubules. The activity of the renal epithelium no doubt is due, like that of the salivary glands, to an inherent secreting force of its own, probably controlled by secretory nerves; but it is also dependent upon the activity of the circulation, and especially on the quality of the blood. We have already seen that the materials which the blood conveys to the kidney for excretion will vary with the activity of all the bodily functions, and we need not return to this subject except with respect to *the influence of digestion and assimilation on the urine.* During gastric digestion a quantity of acid is withdrawn from the blood to furnish the gastric juice, and this loss of acidity in a fluid already alkaline makes itself felt in the urine, which soon becomes less acid, or even alkaline. This reaction increases when absorption begins. Water and salts enter the blood, and augment still further the alkalinity of the urine, the salts being chiefly alkaline; the total volume of the blood and the arterial pressure rise; and the renal secretion is increased. Finally, the products of the actions of the liver, lungs and

other metabolic organs upon the proteids and glucose, urea and its allies, also enter the blood and appear in the urine, in comparative excess. This condition of the urinary function and urine, consequent on a full meal, gradually declines. The excess of water escapes; the alkaline salts are voided; the excess of urea and uric acid disappears; and therewith the general characters of the urine change. By the end of three or four hours after the admission of food, the urine is again moderate in amount, more acid, and clear, an increase of acidity following its previous reduction.

The kidneys produce an "internal secretion" which restrains or diminishes metabolic waste, including the production of urea.

II. Pharmacodynamics.

The preceding considerations prepare us for the conclusion that what power we may possess over the excretion of urine will be exercised, as far as its water is concerned, chiefly through the circulation; as far as the solids are concerned, chiefly through the blood. These points must be separately studied.

1. *Measures for Increasing the Volume of Urine.*—The amount of water, that is, the volume of urine which is excreted from the glomerulus, may be increased by **diuretics**, the effect being called *diuresis* (διά, through, and οὖρον, the urine). This may be accomplished in various ways:

(*a*) *By raising the pressure in the arteries generally, including the renal*, whilst the pressure in the veins is constant. This is most easily effected by temporarily increasing the amount of water in the system by drinking; by raising the force or the frequency of the heart, or both, by Alcohol, Ether, Digitalis, Squill, Ammonia, Strophanthus; or by constricting the peripheral vessels through the vaso-motor system, *e.g.* by cold to the surface, Digitalis, Squill or other vascular stimulants. These measures are called **cardio-vascular diuretics.**

(*b*) *By dilating the renal arteries*, so that the quantity of blood within them is increased, whilst the pressure in the arterial system generally, and the resistance in the renal veins, remain unchanged. This method of increasing the amount of the renal water may be carried out by acting on the vaso-motor system of the kidneys either locally or centrally. Local depressants of the renal nerves include Digitalis and Squill in the second stage; Spirit of Nitrous Ether; all Volatile Oils and Resins, such as Turpentine, Juniper, Copaiba, Hops, Savin, Cantharides, Camphor, etc.;

Alcohol, Belladonna, Aconite, Nitrates and Nitrites. Central renal vascular depressants are chiefly or solely emotional impressions which are not available as pharmacodynamical means. A powerful reflex dilator of the renal vessels is cold to the surface. Such measures are **local vascular diuretics.**

(*c*) *By combining the two previous means*, when still more profuse diuresis will be the result. This occurs in the second stage of the action of Digitalis and Squill according to some authorities, and in the application of cold to the surface.

2. *Measures for Diminishing the Volume of Urine.*—The volume of urine might be diminished by employing the opposite set of influences to those just described. These are obscure, however, and of little therapeutical interest; and the student may be left to work out the different systems for himself.

3. *Measures affecting the Secretion of Urinary Solids.*—The activity of the *renal epithelium, i.e.* the excretion of solids and of a certain amount of the water, may be modified by influences of two classes.

(*a*) *By measures and conditions which affect the renal cells through the composition of the blood in general.*—Of these the state of digestion, including the selection of food, is the most important. The quantity of food; its richness in proteids, carbohydrates, and salts of different kinds; the relative amount of work thrown upon gastric or acid, and duodenal or alkaline digestion; and the vigour of hepatic metabolism, as determined by so many causes, including exercise, oxygenation and the use of drugs—may all be made use of by the pharmacologist in altering the composition and relative proportions of the urinary solids.

One of the easiest and most important of these alterations is in the *chemical reaction* of the urine. The natural acidity of the urine can be *increased* by excess of food as a whole and of proteids, sugar and starch in particular, by deficiency of water, by certain wines and spirits, by Boric, Salicylic and Benzoic Acids, and by an excess of Tartaric and Citric Acids. The mineral acids have an insignificant or even negative power on the acidity of the urine, a fact which is to be carefully noted. Sulphuric Acid is excreted by the kidneys (in part), but as neutral sulphates; Hydrochloric Acid as neutral chlorides, Phosphoric Acid as phosphates; Nitric Acid is believed to increase the ammonia in the urine by diminishing its natural conversion into urea, so that it may have an alkaline influence; and Tartaric, Citric and Acetic Acids escape as alkaline carbonates, unless given in excess.

On the other hand, we possess abundant and powerful

means of rendering the urine *alkaline*. Of foods, the most effective in this direction are fruits, milk and fish, as they throw into the blood a quantity of alkaline citrates, tartrates, acetates, carbonates and phosphates, which are directly or indirectly excreted by the kidneys. Piperazine and the whole group of Alkalis and Alkaline Earths have an alkalinising effect on the urine, excepting Ammonia, which is broken up in the system and excreted as urea. Thus the fixed alkalis are entirely unlike the mineral acids in exercising a powerful and available influence on the reaction of the urine.

(*b*) *By measures which affect the renal epithelium specifically.*—Whatever may be their alkalinising value in the blood, certain substances have a special influence on the urine by *specifically acting upon* the renal cells. Thus Potassium and Sodium possess equal values as alkalinisers of the *blood*, but Potassium will much more powerfully and more quickly neutralise the acidity of the *urine*, because whilst Sodium is excreted partly by the bile and bronchial mucus, or locked up in the system as the neutral sodium chloride, Potassium stimulates the renal epithelium, which excretes it as the carbonate. Sodium does, however, possess a degree of specific action on the kidneys, especially its Phosphate and Acetate. Lithium closely resembles Potassium in this respect; Ammonium, although not an alkaliniser, has a similar influence; and Magnesium and Calcium are distinctly stimulants of the renal epithelium, as is well seen in some natural mineral waters. Now, in passing through the cells, these salts necessarily carry with them a certain amount of water from the capillary plexus around the tubules, and, if abundant, actually produce diuresis. They thus furnish us with another group of diuretic measures, which we call the **saline diuretics**, chiefly alkaline in their influence on the blood and urine, but at the same time independently active as specific renal stimulants. Let it be carefully noted that the saline diuretics do not, as far as we know, directly affect the renal circulation; but that we possess in them an indirect means of influencing the capillary plexus around the tubules, and thus the whole renal circulation and the general blood-pressure, especially the pressure in the veins.

Another great group of natural substances in the materia medica have a specific effect on the renal epithelium, namely, the Aromatic Oils, Oleo-resins and Balsams. The chief of these **glandular diuretics** are Turpentine, Juniper, Copaiba, Cubebs, Cantharides and Hops; whilst Jaborandi, Alcohol, Aconite and many more act partly in the same way. All these substances, either as such or after decomposition, are

excreted (in part) by the renal cells, and carry with them, like salines, so much water, besides dilating the renal vessels, as we have already seen. The degree in which the different members of this great class act upon the renal cells varies widely, however: thus, Juniper and Copaiba are powerful diuretics, greatly increasing the urinary flow, whilst most of the others have but little effect on the volume of urine, possibly because their action on the renal vessels, which accompanies their action on the cells, does not favour the escape of fluid. Thus Turpentine and Cantharides, two most powerful renal stimulants, sometimes diminish, sometimes increase the urinary water, and may even cause hæmorrhage from the glomerulus. The diuretic action of Caffeine is in part on the epithelium.

Opposed to these renal stimulants are *renal sedatives or depressants* which appear to diminish directly the activity of the renal cells, when they reach them through the blood. Morphine has this effect, and possibly Quinine and other substances.

4. *The Bladder and Urinary Passages.*—In connection with the physiological actions of drugs on the kidneys may be mentioned certain substances that affect the bladder and lower urinary passages, and the urine which they contain and discharge. Belladonna and Hyoscyamus appear to be *depressants* of the nervo-muscular structures of the bladder. The same effect is produced indirectly by *alkalis* and other measures that reduce the acidity of the urine. An *astringent* action on the urinary mucous membranes is exerted by Uva Ursi, Buchu, Pareira, Hygrophila and Agropyrum, which are also mild *antiseptics*. The urine can be more thoroughly *disinfected* with Urotropine and other artificial products; and Copaiba, Oil of Sandal Wood, Cubebs, and Turpentine and its many allies, whilst possessing a similar action, appear to be remote local stimulants of the mucous membranes of the ureters, bladder and urethra.

III. Pathological Relations.

The disorders of the renal functions, which will be taken by us to illustrate the application of the measures just noticed, may be summarised as follows:

1. *Disorders of the fluid secretion referable to the general blood-pressure.*—(*a*) *Diminution of the general arterial pressure*, which is generally referable to heart disease, leads to marked disturbance of the urinary flow. We saw under the head of the circulation (page 548) how dilatation of the heart lowers the pressure in the arteries and raises it in the veins,

i.e. lowers it in the afferent vessel of the glomerulus, and raises it in the efferent vessel, thus causing *congestion of the kidneys.* The urine in this class of cases contains albumen and possibly blood proceeding from the engorged veins; it falls in quantity in consequence of the fall in the arterial pressure, and of obstruction in the tubules, which become choked with fibrinous casts; and the total excretion of solids is diminished as the result of retardation of the blood current.

(*b*) *Increase of the general arterial pressure* is associated with that form of Bright's disease of the kidneys known as the "Granular or Contracted Kidney." Here the urine is very abundant, probably reaching several times its normal volume, is very light in colour and weight, and may contain a trace of albumen. The tension of the radial artery is high; the left ventricle is hypertrophied; and the patient often dies either of secondary dilatation of the heart, or of rupture of an artery in the brain. As far as the kidney is concerned, the condition is one of constant diuresis.

2. *Disorders of the fluid secretion, referable to the local blood-pressure.*—(*a*) *Certain nervous conditions* disturb the pressure in the kidney by causing contraction or dilatation of the renal vessels, and thus modifying the amount of urinary water. Such a condition may be either central or local, direct or reflex. Thus hysteria is attended by an alternately profuse and deficient flow of urine. Disease of the medulla and its neighbourhood may give rise to profuse diuresis (*diabetes insipidus*), which has been traced in other cases to disease of the renal nerves. Reflexly, the chief cause of disturbance of the renal secretion is injury or disease of the prostate or urethra, which even may lead to fatal suppression.

b. Morbid conditions of the blood-vessels of the kidney, such as disease of the glomeruli, arteries and veins, which form one of the elements of Bright's disease, produce a variety of disturbances in the volume and constitution of the urine, according to their exact seat and degree. Pressure on the trunks of the renal vessels by abdominal enlargements also may cause serious disturbance of the renal circulation, with albuminuria, hæmorrhage, or even suppression of urine as the result.

3. *Disease of the secreting epithelium.*—This constitutes another element of Bright's disease. The diseased cells fail in function, choke up the tubules, press upon the capillary plexus, and thus give rise at once to stagnation of the blood current and resistance to the filtration of water through the glomerulus. The clinical phenomena of this condition (commonly called the Large White Kidney) are very definite.

The urine falls in volume; the solids are absolutely diminished, but relatively increased, so that the specific gravity is high; and in their place there appear albumen, probably derived directly from the capillary plexus, blood from the same source or from the glomeruli, and casts formed of diseased cells, fibrin, etc. The blood is poisoned by accumulation of urea or its allies. The systemic vessels become diseased, and the heart hypertrophied; and the blood-change and cardio-vascular disease together lead to marked breathlessness, and to escape of serum into the tissues and serous cavities, constituting renal dropsy.

4. *Rise of pressure within the uriniferous tubules* is a serious cause of complete arrest of the secretion. This is one of the effects of fulness of the capillary plexus, and of epithelial accumulations in the tubes, just noticed; and may also originate in obstruction of the ureter, disease or injury of the bladder and prostate, or stricture of the urethra.

5. *The condition of the blood.*—This is the most common of all the causes of derangement of the urinary secretion. A number of the disorders of the urine, as regards its reaction and relative composition, can be traced to dyspepsia, hepatic derangement, and defective oxygenation or metabolism; and even albumen, sugar and bile may find their way into the urine from the same causes. One striking disorder of the urine is characterised by unnatural alkalinity and by its effects in precipitating certain solid constituents. The urine is turbid from precipitation of phosphates and carbonates; and these are deposited in the passages, causing pain and irritation. If the natural acidity of the urine between meals be insufficient to dissolve these alkaline deposits, concretions are formed, and grow at each period of indigestion, until they form a *calculus*, which may travel downwards and be expelled with the urine after great suffering.

A similar disorder of the urine is characterised by excessive acidity. This has different causal relations, but the ultimate effects are practically similar—the precipitation of uric acid, and possibly the formation of calculus. Excessive acidity is chiefly met with in the subjects of disorder of the liver from indulgence in proteid food (page 516); and may be accompanied by an excess of urea and uric acid, by diminution of water, and occasionally by traces of albumen and sugar.

IV. Natural Prevention and Recovery.

We have seen that so many of the disorders of the urine are but expressions of derangements of the blood and of the

great organic functions, that it is unnecessary to say that natural recovery frequently occurs in connection with the kidneys. Conversely, improvement in the condition of the urine is an evidence of the spontaneous return of the stomach, intestines, liver, heart, etc., to the normal state when the causes of their disorders have been removed.

The kidneys themselves possess several provisions for natural recovery. They meet increased work by increased action; compensatory hypertrophy of the one kidney occurs if the other kidney fail; and an intimate vicarious relation exists between the kidneys and the skin and bowels. The rise of arterial pressure and the hypertrophy of the left ventricle associated with Bright's disease are not strictly morbid phenomena, but evidences of conservative or recuperative reaction, which compensates for the damage and the disability of the secreting tissue by promoting diuresis and excretion. The practical therapeutist respects these natural methods in arranging his treatment.

V. Therapeutics.

A careful consideration of the four preceding sections specially impresses two facts upon us. First, the rational treatment of any case of renal or urinary disorder must be founded upon an appreciation of the influences of other organs on the kidneys; and, second, treatment may be directed to the kidneys as often for diseases of other organs as when they are themselves at fault: diuretics will be as frequently employed to relieve the heart as to stimulate the cells of the kidney.

1. (*a*) *Renal congestion from heart disease.*—This may be taken as the type of renal disorder from diminished blood-pressure, whatever its cause; and such being the pathology of the condition, the line of rational treatment is obvious. We must restore the normal relations of the general circulation, that is, strengthen the heart, fill and keep full the arteries, and empty the veins. How this is to be done has been already discussed in Chapter X., and need not be repeated here. We are now able to estimate the value of two sets of diuretic remedies which are employed successfully in such cases, namely, the *cardio-vascular diuretics* and the *saline diuretics*. Digitalis and Squill exactly fulfil the indications just mentioned as regards the heart, the arteries and the veins. They increase the cardiac vigour and the period of rest; sustain the arterial tension at a moderate height; and empty the veins forwards by prolonging the diastole. At

the same time, partly by these effects and partly by their local action on the renal vessels, they cause a true diuresis from the Malpighian bodies, and increase the force of the circulation through the renal veins. Ammonia, Alcohol or Scoparium may be combined with these drugs; and here it may be remarked, once for all, that combination is peculiarly useful in diuretics. Saline purgatives also assist this action. Thus the Sulphates of Sodium and Magnesium, Acid Potassium Tartrate, Sodium Potassium Tartrate, Potassium Acetate and the Citrates of Potassium and Ammonium are, in the first place, saline purgatives, thus relieving general venous congestion; and, secondly, act upon the renal epithelium, draining the over-distended capillary plexus, and accelerating the circulation through the glomerulus. In other instances dilators of the renal vessel may be combined with these remedies, including Juniper and Spirit of Nitrous Ether.

(*b*) *Disorder or disease of the kidneys in association with excessive blood-pressure; Bright's disease with contracted kidney.*—In the early stages of this disease, when its cause may be discovered in indulgence in food and alcohol or disorder of the liver, treatment consists in thorough reform of diet, free purgation, and elimination generally. Mercurial purgatives followed by salines are especially valuable. In the more advanced and graver form of high arterial tension, the disease is usually beyond our control. All that can then be done is to remove its evil effects and relieve distress. The food should be moderate in quantity, and chiefly non-nitrogenous; stimulants must be avoided; moderate rest of body and mind insured; and various drugs administered. We are unfortunate in possessing but few medicinal means of reducing peripheral resistance for any length of time without depressing the heart; but the Iodide, Chlorate, Nitrate and other salts of Potassium, Sodium Nitrite, Trinitrin, Belladonna and its allies may be tried, and purgatives are still called for.

2. (*a*) *Urinary derangements from nervous disorder or disease.*—The treatment employed here must be directed to the nervous system entirely. Potassium Bromide, Valerian and other anti-spasmodics, including moral treatment, will relieve hysterical diuresis; and Opium and Ergot are successful in many cases of polyuria of obscure and probably nervous origin.

(*b*) *Local vascular disease.*—If the emulgent veins are obstructed by abdominal enlargement, this must be immediately removed, if possible—by tapping the peritoneum, for example, or by inducing premature labour. In disease of the renal vessels we can do but little by way of direct treatment beyond

relieving disorders as they arise; regulating the flow of urine as well as possible, especially stimulating it if it threaten to become deficient; and removing the excrementitious products by the bowels and skin, when the specific gravity falls.

3. *Disease of the tubules; "acute desquamative nephritis," "large white kidney."* — This is the form of renal disease in which there is the greatest or most constant danger of deficient excretion, and of the consequences of the same throughout the system. The indications for treatment are obvious. We must relieve the diseased cells of as much work as can be dispensed with safely by the blood and tissues. The rational methods of relieving the renal epithelium are: (1) by reducing the food in quantity and nitrogenous richness; and (2) by diverting the excrementitious products to other channels. Hydragogue purgatives are especially valuable in this form of Bright's disease; and the warm-air or vapour- or water-bath, warm drinks and Jaborandi will successfully relieve the kidneys by perspiration. Renal stimulants, such as the saline and specific diuretics, might, on the other hand, exhaust the cells, already weakened by disease; but in certain cases they are highly useful even in this condition, for they may exert that amount of stimulation on the renal cells which, on the principle of alteratives in general, will lead to their restoration. If we believe that the tubules are blocked by cellular and inflammatory products, we must clear them by a system of flushing or diuresis. For this purpose Distilled Water is the best diuretic; Digitalis and Squill are also valuable, as producing but little local irritation, and tending to prevent venous congestion.

In this or in any other form of renal disease, urgent symptoms of uræmia must be quickly relieved by venesection, the administration of Chloroform, free purgation, and, if possible, profuse diaphoresis with the wet-pack, hot-air bath or Pilocarpine. The anæmia generally demands Iron in some form.

4. *Obstruction in the urinary passages.*—The most common cause of this serious disease, namely, stricture of the urethra, is amenable to surgical treatment, and so is impacted calculus in the ureter, but when the obstruction is above the bladder it is very rarely bilateral, and the unaffected kidney takes on the double function of the two.

5. *Disorders of the blood, liver and digestion: Gravel and Calculus.*—The immediate treatment of these secondary disorders of the liver, in their early stage, has been already suggested: careful dieting, and the occasional administration

of cholagogue purgatives, stomachics and antacids. If gravel or calculus have actually formed, several other measures are still open to us, whilst the same line of treatment is persevered in to prevent fresh growth. We attempt—usually in vain—to dissolve the stone *in situ* by *lithontriptics, e.g.* by continuous administration of Piperazine or Potassium Citrate, or of acids, as the nature of the calculus demands; we promote its discharge by means of abundant water-drinking, particularly at recognised spas, such as Contrexéville; we relieve pain and hæmorrhage, and treat mucous and purulent discharges on general principles; and, finally, we can employ surgical methods for its removal bodily or in fragments.

6. *Affections of the urinary tract.*—Inflammation of the pelvis of the ureter, the ureter, bladder and urethra, caused by gravel, calculus or different infections, can be controlled with the disinfectant and other remedies mentioned under the head of Pharmacodynamics (4). Spasms, enuresis and other vesical disorders are peculiarly amenable to treatment with Belladonna, Hyoscyamus and alkalis.

CHAPTER XIV.

THE BODY-HEAT, AND ITS REGULATION: THE SKIN.

I. PHYSIOLOGICAL RELATIONS.

HEAT is *produced* in every act of vital energy; is *distributed* throughout the body; and is finally *lost* in the surrounding medium. In so-called "cold-blooded" animals, the vital heat is lost as rapidly as it is produced; in "warm-blooded" animals the heat produced does not escape until a certain amount has *accumulated* within the system. Thereupon loss sets in, and exactly balances the production, whilst the accumulated store remains constant, and is known as the "body-heat," amounting, in man, to 98·4° Fahr.

So wide is the range, so sudden are the changes, of the external temperature to which man is exposed, and so variable the amount of heat produced in the system at different moments, that in the course of its evolution the body has come to possess a complex and sensitive nervous mechanism by which its temperature is controlled. This mechanism consists of governing centres, afferent nerves from impressionable parts, and efferent nerves to active organs. *The afferent thermal nerves*, originating in the skin, and possibly in other parts of the body, such as the mucous membranes and viscera, carry impressions of temperature (heat and cold) to the brain and cord. There these impressions are specially received by three of the great centres, viz. the *cerebrum*, where they become *sensations of temperature;* the *sweat centres* in the cord and medulla; and the *metabolic or trophic* centres, the centres of nutrition, in the brain and cord. They also fall into the *vasomotor*, *cardiac*, *respiratory* and possibly the *renal* and other visceral centres. *Efferent impulses* from the sweat centres proceed to the sudoriparous glands, which they stimulate or depress as the case may be; from the metabolic centres they are directed to the various sources of heat production—the muscles, glands, etc., which they either depress or stimulate. Through the other centres named the circulation in the skin is modified, the blood-pressure generally, the respiration, the renal secretion, and probably every other bodily function in some degree.

Thus, when the temperature of the air rises, the regulating mechanism comes into action, and two great effects are produced: (1) there is *increased loss of heat* by the perspiration, by cooling of the blood in the dilated cutaneous vessels, by

cooling of the blood in the lungs (increased respiration), and by contraction of the splanchnic vessels; and (2) there is *diminished production of heat* in the muscles, glands, etc. The same effect follows a rise of the internal temperature due to increased metabolic activity, such as muscular exercise: a "warm glow" is felt, the skin flushes and perspires, the circulation and respiration are increased, and the activity of other metabolic organs, such as the liver, is for the time lowered. The skin is the principal channel of loss of heat in man; but during and after exertion a large amount of heat must be carried off by respiration, which is familiarly known to be the chief means of refrigeration in the dog.

Conversely, if the temperature of the surface be *lowered* by cooling of the atmosphere, two reflex effects are at once produced through the nervous system, viz.: (1) *diminished loss* of heat, by contraction of the vessels of the skin, by arrest of perspiration, and by reduced activity of the circulation and respiration, and by splanchnic dilatation; and (2) *increased production* of heat in the metabolic organs, especially the muscular, digestive and circulatory. A similar result follows lowering of the internal temperature by diminished metabolism in some of the organs. Thus Quinine and Salicylic Acid, whilst they diminish the amount of the urea and therefore probably of the heat produced in the system, make little or no impression on the temperature of a healthy man, doubtless because the channels of loss are partially closed, and the metabolism of certain organs increased, by the regulating mechanism.

II. Pharmacodynamics.

1. *Temperature of the External Media.*—This is completely under our control. The atmosphere is the ordinary external medium of loss or gain of the bodily temperature, and the air of every well-constructed room or ward can be cooled or warmed at pleasure. We may select the *climate* in various ways, according to its temperature; the sub-tropics, such as Madeira, Egypt and the Riviera, being especially valuable as affording warm climates. When a more rapid and extreme influence of the external temperature is desired, *water* may be substituted for air, in the form of baths, wet-packs and sponging. The varieties, actions and uses of water applied in these several ways are described in the next chapter. By means of the *prolonged cold* bath, at a temperature varying between 32° and 60° Fahr., heat may be readily abstracted from the body; and the cold wet-pack, cold

affusion, or sponging a part or the whole of the exposed skin with cold or even tepid water, has a similar effect. These measures are known as **external refrigerants.** Heat may be *locally* abstracted by similar means, which will also have a general effect in reducing the temperature of the body. Thus, cold water may be injected into the rectum or vagina; ice or wet compresses applied to the skin; ice or cold water swallowed; or irrigation with cold water may be used over a part. The cooling that attends evaporation is a powerful means of reducing the local temperature; and a variety of saline, spirituous and acid solutions, such as Ammonium Carbonate or Chloride, Spirit and Water, Brandy and Water, Vinegar and Water, or other combinations of salts, acids and spirits, may be employed for this purpose.

2. *The Cutaneous Circulation.*—This affords us a powerful means of abstracting the body-heat, inasmuch as we can modify the fulness of the vessels and the rate of flow through them. Thus we may cool the blood by dilating the cutaneous vessels by the warm bath, by Alcohol, Spirit of Nitrous Ether or warm draughts, or by these measures combined. Opium and Chloral Hydrate have the same effect. If the blood-flow be accelerated through the dilated vessels, the refrigeration is increased, and in this way cardiac stimulants of every kind, such as Alcohol and Digitalis, reduce the body temperature. Draughts of water, whether cold or hot, cause temporary distension of the vessels, and produce a similar effect. The opposite methods, for preserving the heat of the body by contracting the superficial vessels and reducing the activity of the cutaneous circulation, are of no therapeutical interest.

3. *The Sweat-glands: Diaphoretics, Sudorifics, Anhidrotics.*—The function of perspiration is under our control in almost every portion of its complex mechanism.

a. Measures which increase the amount of perspiration are called **diaphoretics** or **sudorifics.** The *afferent thermic nerves* in the skin can be readily stimulated by means of heat, as described in Chapter XV., whether by moist heat in the form of the warm water- or vapour-bath, or of packs; by dry heat, as in the Turkish and radiant-heat bath; or by general warmth of the air, the room, or the clothing. The familiar effect of Alcohol in inducing perspiration appears to be chiefly produced in the same way. *Other afferent nerves* may be used to stimulate the sweat-centres reflexly, such as those of the mouth, throat and stomach by hot spiced drinks. Perspiration may be induced by acting on the *sweat centres* directly. This may be accomplished by measures which increase the venosity of the blood, such as narcotics,

including Opium, Chloral Hydrate, Chloroform, Ether and Alcohol in the later stages of their action; by Nicotine (Tobacco), by Pilocarpine (Jaborandi) in part; and by all measures which increase the flow of warm blood through the sweat-centres, such as hot drinks. The *efferent nerve-trunks* of perspiration may be stimulated by electricity, but this method is not therapeutically employed. The *terminations of the nerves* in the sweat-glands and the secreting cells are powerfully stimulated by Pilocarpine, which causes a profuse and rapid flow of sweat; and by Eserine. Diaphoresis will be favoured by a free supply of blood to the glands, that is, by *dilating the vessels*, as just described. A number of substances induce diaphoresis without their mode of action being clearly understood, such as Ammonium Citrate and especially Ammonium Acetate, which possibly stimulate the secreting cells, and are excreted by them along with an increased amount of water, as we see in the kidneys; Antimony; Dover's Powder; the aromatic substances in a degree, especially Camphor and Benzoic Acid; and several empirical remedies, namely, Serpentary, Sassafras, Sarsaparilla, Aristolochia, Guaiacum, Mezereon and Senega.

It will be observed that several of our powerful diaphoretics act on more than one part of the perspiratory mechanism. Thus Alcohol dilates the cutaneous vessels, increases the rate of blood-flow through the skin, and stimulates both the afferent nerves and the centres of perspiration. Warm applications to the skin and hot drinks also influence both the circulatory and the perspiratory part of the refrigerating function; and by a combination of these and other means we may produce a very powerful effect. When this is the result, and the sweat flows abundantly from the surface, the measures and the effect are said to be **sudorific** (*sudor*, sweat, and *facio*, I make). Diaphoretics naturally are *refrigerants*.

(*b*) *Measures which diminish* the amount of perspiration are called **anhidrotics** (ἀν, priv., and ἱδρώς, sweat). Some of these act upon the *afferent* nerves, especially moderate local cold, obtained by fanning, light clothing, and a cool atmosphere generally; and sponging with cool, tepid or even hot water. Others depress the sweat centres—possibly in part directly, certainly indirectly by strengthening the heart and respiration, and thus reducing the venosity of the blood which powerfully stimulates them. Such are food, which is one of the best means of preventing the "cold sweats" of exhausting diseases, Alcohol, Ammonia, Strychnine, Iron and fresh air or good ventilation. The *efferent* secretory nerves may possibly

be depressed by Opium, which in certain combinations, *e.g.* with Diluted Sulphuric Acid, is an anhidrotic, acting either in this or in some unknown way. By far the most powerful anhidrotic drugs act upon the *terminations* of the secretory nerves in the glands, namely, Atropine and Hyoscyamine. The effect of these alkaloids or of the Extract of Belladonna is very marked. Measures which contract the blood-vessels of the glands will *pro tanto* be anhidrotic also. Such are sponging with solutions of Sulphuric Acid and Water or of Tannin, which constringe the parts, and Oxide of Zinc given internally.

Lastly, the *modus operandi* of certain anhidrotics is still doubtful, and their employment so far empirical, *e.g.* Zinc, Quinine and Opium in particular circumstances. It is possible, however, that these and other measures control the pathological cause of the sweats, in a manner to be afterwards indicated.

4. *Other Channels of Loss of Heat.*—The kidneys and the bowels afford us a direct means of reducing the temperature of the body by the abstraction of an increased amount of warm excretions, in the form of urine and watery motions. In the case of the bowels the effect is decidedly assisted by the reflex dilatation of the cutaneous vessels which accompanies purgation, as described in Chapter VI.

5. *The Heat-forming Tissues.*—In discussing metabolism in Chapter IX., we found that we possess the power of diminishing tissue change, and the production of heat, by various means. Here we shall refer only to certain drugs which possess this action. We call these **antipyretics** (ἀντί, against, πυρετός, fever). The most powerful of these is Cinchona (Quinine), which interferes with metabolism generally, lessens the amount of heat produced, diminishes the excretions, and spares the organs. Berberis, Salicin, Salicylic Acid and Oil of Wintergreen, Phenazone, Phenacetin, and Acetanilide have a similar but less powerful action. Whilst these drugs reduce or spare the activity of the tissues, they have but little influence in reducing the temperature of healthy individuals, this effect probably being prevented by the ordinary mechanisms of regulation. Alcohol also diminishes tissue waste, apparently in a different way from Quinine, namely, by being itself decomposed in the tissues with great readiness, thus sparing the organs. Even an increased amount of heat is generated in the tissues by the oxydation of Alcohol, but so greatly does it stimulate refrigeration, as we have seen, that its total effect on the organism is antipyretic. The Aromatic substances have a less powerful influence in diminishing

metabolism. Digitalis, Aconite and Veratrine possibly have an antipyretic effect, like Alcohol, but their mode of action is obscure, unless it occur entirely through the circulation, as has been already suggested.

III. Pathological Relations.

The mechanism concerned in the regulation of the body-heat is liable to disorder, when heat-forming or heat-losing organs are diseased. Elevation of the body temperature, or *pyrexia*, one of the elements of *fever*, is very rarely absent in illness of any consequence. An abnormal fall is seen as an effect of extreme cold or of exhausting diseases, but does not require to be discussed here.

Pyrexia.—The temperature of the body may be abnormally raised in several ways. Thus we meet with pyrexia in injury or disease of the *heat centres* or *tracts*, especially injury of the cervical and dorsal regions of the spinal cord. *Exposure to excessive heat* induces "heat fever," a variety of sunstroke which is common in India. More familiar to us is the simple fever brought on by *interference with the refrigerating function of the skin*, as the effect of exposure to cold or damp. This is known as a "chill." A powerful impression of cold on the afferent nerves of temperature appears to have thrown the regulating mechanism into disorder; perspiration is arrested; the cutaneous vessels are spasmodically contracted; rigors, shivers or chilly feelings ensue; and the heat thus retained in the blood quickly raises the temperature. But "chill" is far more often an effect of other conditions than simple exposure to a cold atmosphere. Most of the serious disturbances of the production, of the loss, and especially of the regulation of body-heat, constituting fever, can be traced to the actions of micro-organisms and their products. These actions are of various kinds:—

Increased production of heat at the original focus, an injured, poisoned or inflamed part, contributes in some degree to the accompanying fever. The local wound, which acts as a focus of heat, may become septic; organisms are absorbed into and infect the blood; fresh foci of disease are set up in the tissues; and the natural refrigeration of the blood is reduced by the disturbances of the skin, lungs and circulation which always accompany serious illness.

The *increased production of heat in the tissues generally* which is probably present in all kinds of fever, whatever its cause, is another cause of the pyrexia. The increased activity of katabolism is proved by the rapid wasting of the

tissues, by the increase of urea and other excretions, and by the pyrexia as tested by the thermometer—all obvious phenomena in every case attended with fever.

In the specific fevers there is at work another cause of oxydation in the tissues, which furnishes an *extraneous* addition to the body-heat. Many of these diseases, such as typhoid fever, tuberculosis, and septicæmia, being associated with the presence of organisms in the tissues, the life of such organisms (as well as the processes of decomposition with which they are associated, and the destruction of the tissues which they produce) must be a source of heat within the body, in a way perfectly foreign to the normal processes, though closely resembling some of them.

In addition to these causes of increased heat production and diminished heat loss, it is certain that interference with the regulation of the two mechanisms occurs in fever; and it is probably the essential cause of pyrexia.

Disorders of Perspiration.—Only two disorders of perspiration concern us here, viz. (1) *excessive sweating*, and (2) *deficient sweating.*

1. *Excessive sweating, hidrosis, hyperidrosis*, is found in a great variety of morbid conditions. In some kinds of fever, such as rheumatism, its pathology is bound up with the pathology of the fever as a whole. In disorders of respiration, as we have seen, dyspnœal sweats are due to stimulation of the sweat centres by venous blood. The "cold" sweats of wasting diseases such as tuberculosis, especially during sleep, appear to be due to the same cause, associated with fever, and anæmia and coldness of the skin, which prevent evaporation and "insensible perspiration," and thus give rise to a profuse collection of visible sweat, as well as great depression of the bodily strength from interference with cutaneous excretion. "Critical" sweats are referred to sudden changes in the disturbance of the vaso-motor system of the skin present in fever. Toxic sweating, as is seen in alcoholism and gout, may be induced in several ways.

2. *Deficient sweating: anhidrosis.*—Dryness of the skin occurs at the beginning of most fevers, and throughout the course of most of them more or less interruptedly. It is also marked in some diseases and disorders of the urinary functions, such as Bright's disease; in diabetes and myxœdema—metabolic disorders; in certain diseases of the skin itself; and as the result of poisoning by atropine (belladonna), etc. Manifestly different parts of the nervo-glandular apparatus are disordered in the different cases.

IV. Natural Prevention and Recovery.

The more ordinary disturbances of the body-heat are commonly regarded as manifestations of the salutary activity of the regulating mechanisms, that is, as a means of natural recovery. Fever is a method of readjustment, and the remedial effect of it as a whole is maintained by some authorities. The dilated vessels of the integuments, the sweats, the increased frequency of the pulse and the quickened breathing are methods of cooling the body automatically. On the cessation of the cause of the fever, the temperature of the body generally returns to the normal, either spontaneously or with the artificial assistance of the therapeutist. Occasionally, however, the temperature rises beyond all control of the regulating mechanism, which appears to be paralysed, and the subject dies of the effects of excessive heat or *hyperpyrexia*—107°, 110° F., or even higher. In most cases of death from fever the fatal result is due to one or more of the other factors of fever, especially the body-waste and the visceral degeneration.

V. Therapeutics.

A great part of our knowledge of the body-heat, its regulation and its disturbances, has been derived from careful observation of the results of treatment; and the use of measures to control fever—**antipyretics** or **febrifuges** (*febris*, fever, and *fugo*, I drive away)—is one of the most successful, as well as the most rational, of therapeutic proceedings.

1. *Preventive Treatment: Antiperiodics.*—The periodical return of certain fevers may be prevented by means of **antiperiodics.** The most powerful of these is Cinchona, with its constituents, especially Quinine; Salicin, Salicylic Acid and Salicylates are not so powerful; less important are Nectandra and its alkaloid Beberine.

2. *Remedial treatment.*—With the abundant means at our command which we have discussed in the second section, the remedial treatment of pyrexia is very easy, inasmuch as we can lower the temperature of the surface of the body to any degree we please; for instance, by the cold bath. But we soon discover that it is one thing to reduce pyrexia, and another thing to treat fever. We can readily assist the refrigerating mechanism of the body, and we can even so far reduce the metabolic activity of the tissues, but our remedies can rarely reach the actual cause of the disorder, and the temperature rises again. As far as possible, how-

ever, we are bound to begin by discovering and attacking the causes; and if we fail in this, we must combat the fever itself, so as to prevent its injurious effects on the system.

(*a*) *Injury or disease of the nervous system*, as a cause of pyrexia, is generally beyond treatment. If the temperature rise to a dangerous height, it must be treated with the refrigerating measures presently to be described.

(*b*) *Heat-fever* is rationally treated by immediate removal of the patient to a cool, open atmosphere, and the employment of refrigeration in the form of cold affusion.

(*c*) *Interference with the cooling function of the skin* is rationally treated by increasing the loss of heat with refrigerants. Refrigeration is practically carried out by lowering the temperature of the external medium moderately; by increasing the cutaneous circulation; and by stimulating the secretions with the warm bath, with hot, spiced alcoholic drinks, or with a brisk purgative. When fever rises high, the temperature of the room must be kept low, and the skin sponged; and if the pyrexia increase to a dangerous height, the prolonged cold bath or wet-pack must be employed according to the method described in Chapter XV. (p. 614).

The medicinal remedies chiefly employed as refrigerants in symptomatic fevers, *i.e.* in the pyrexia attending ordinary local inflammation of the lungs, bronchi, fauces or other parts, are the diaphoretics, including Hot Water, Alcohol, Liquor Ammonii Acetatis, Ipecacuanha and Opium in the form of Dover's Powder, Antimony as the Pulvis Antimonialis or Vinum Antimoniale, Tincture of Aconite and the Phenol derivatives. The use of the warm bath may be combined.

(*d*) *A focus* of increased heat-production, such as an abscess, must be removed as soon as possible.

(*e*) *Increased metabolism generally*, which is the principal cause of pyrexia, is rationally treated with Quinine, Salicin, Alcohol, the Phenol derivatives and Aromatic Substances. The rule commonly followed is to give a single full dose (*e.g.* 10 grains of Quinine) when the temperature rises above a certain point, say 103° or more, according to circumstances; or repeated moderate doses or a single large dose may be given in anticipation of the exacerbation. Ague is thus combated with Quinine, and Rheumatism with Salicin or the Salicylates.

(*f*) *Foreign organisms or substances in the system.*—Fever produced by these bodies and their life-processes would be rationally treated with measures directed against them. We attempt to do so by administering internally some of the substances which are unfavourable to lowly organised life

apart from the body or in wounds on the surface of the body, the antiseptics and disinfectants, and which may be named **disinfectant antipyretics.** The value of Quinine in ague is so great that it is referred to a specific influence upon the organism of the disease. The powerful effect of Salicin and Aspirin in rheumatism has been explained similarly. Antitoxin serums are employed on this principle.

(*g*) *Combinations of causes.*—Just as fever is generally traceable to a combination of the preceding causes, so it must, as a rule, be treated by the application of remedies that act in several ways, or by a combination of antipyretic measures. Thus Alcohol will be indicated in many cases of fever, because it dilates the vessels of the skin, increases the circulation through them, and stimulates the sweat glands, whilst it spares tissue damage, and acts as an antiseptic antipyretic. Quinine will be employed with advantage when the temperature mounts high, since it controls the metabolism not only of the animal tissues but of the septic and foreign organisms which may be wasting these. Indeed, all the measures which we have analysed under the preceding heads are to be freely combined, constituting the general treatment of fever. A sufficient supply of nutritious and digestible food is essential, to compensate for the great increase of metabolism which is going on. Alcohol is a true food, easily taken, rapidly assimilated, and yielding abundance of energy at little cost to the tissues, and therefore it is in general use in fevers, although it is by no means an indispensable remedy.

CHAPTER XV.

THERAPEUTICAL PROCESSES CONNECTED WITH THE SURFACE OF THE BODY.

THE surface of the body is of great interest and importance to the therapeutist, because it is the region of objective impressions, where influences of every kind may be brought in contact with nerves and vessels, and through them with the nervous centres, the circulation generally, the related viscera, and indeed the entire system. The measures applied to this part appear at first sight to be simple, but their action is extremely complex, and indeed still obscure. On this account we have taken them last in the whole range of remedies, and it will be found that they involve all the systems already discussed, especially the nervous and circulatory. As a group they are very heterogeneous, and we shall select for special consideration three distinct subjects, namely (*A*) *Counter-irritants*, such as blisters; (*B*) *Baths;* and (*C*) *Surgical Applications.*

I. PHYSIOLOGICAL RELATIONS.—The physiological relations of the surface of the body have already been studied under several distinct heads.

The *nerves* are connected not only with the sensorium, but with the vital centres which regulate the vessels and viscera. The cutaneous *vessels* have equally extensive relations. They have the usually nutritive function, and frequently anastomose with the vessels of the underlying viscera; they are part of the great refrigerating apparatus of the body; and they also serve as a great external blood-reservoir, in connection with the systemic circulation.

II. PHARMACODYNAMICS.—When the classes of measures given in the chapters on the circulation and nervous system are compared, it is found that several of them act on both systems, and that their actions may be different or even opposite according to the time for which they are applied. For these and other reasons, a number of them have been collected into a special class, which will now be noticed.

A. Counter-irritants.

These measures may be thus arranged, according to the degree of their action:

1. **Rubefacients** (*ruber*, red, and *facere*, to make) cause increased redness and heat of the parts. Such are Hot Water; Mustard and its preparations; Ammonia and its preparations; the confined vapour of Chloroform, Ether and Alcohol; all Volatile Oils, especially Turpentine, Camphor, Menthol and Thymol; Iodine carefully applied; Emplastrum Picis; Emplastrum Calefaciens; and Emplastrum Calefaciens Mylabris.

2. **Vesicants** (*vesica*, a blister), **Epispastics** (ἐπί, upon, and σπάω, I draw) or **Blisters** produce a rubefacient effect, followed by the development of a blister. They include Cantharides, Mylabris, Mezereon, Ammonia long applied or confined, Iodine, Oil or Liniment of Mustard and Scalding Water.

3. **Pustulants** (*pus*, matter) produce a crop of pimples. They are a small group, consisting of Croton Oil, Tartar Emetic, Silver Nitrate in strong solution, and Ipecacuanha.

Phenomena of counter-irritation.—When a counter-irritant is applied to the skin, the *first* effect is *rubefacient* and stimulant. The cutaneous vessels are dilated by a direct action on their nerves, and the local circulation becomes more free; whilst the irritation of the sensory nerves causes pain of a hot burning character. Reflexly, the cardiac action is accelerated, the cutaneous vessels of other parts contract, the general blood-pressure rises, the temperature is elevated, and the breathing slowed. The highest nervous centres also are roused by the painful impression: perception, consciousness and the emotions are variously disturbed. Cutaneous anæsthesia follows: the irritability and conductivity of the nerves are depressed and pain is relieved.

Prolonged application is generally required to induce the *second* degree of counter-irritation—*vesication*. The reddened area now becomes inflamed: plasma escapes from the vessels, followed by corpuscles; the epidermis is raised, and a vesicle is formed containing a quantity of fluid. The previous anæsthesia is now replaced by considerable local pain, which, if extensive, may depress the viscera—weakening and slowing the heart, relaxing the pulse, slowing the respiration, further lowering the temperature and diminishing nervous energy.

The *third* degree of counter-irritation, *pustulation*, is different in kind from vesication, as well as more severe, the

result being a crop of painful, "angry" pimples or pustules, which are very slow to heal. The remote effects are similar to those of the second degree, but more marked.

Theories of the action of counter-irritation.—Such are the phenomena of this method of treatment: they are obvious to everyone. That one *pain* or other morbid disturbance of sensibility can be modified by another, artificially produced, is common knowledge: the first is inhibited by the second, which appears to take up the attention of the centre of sensation. But it is held by some authorities that the *nutrition* and functional activity of internal parts, as well as their sensibility, are affected by counter-irritants: that when a part at some distance beneath the surface of the body such as a joint, or even remote from it such as the lungs, is in a condition of pain, inflammation, unnatural activity or overgrowth, an effect may be produced upon its nutrition by disturbing the nervous, vascular and trophic conditions of an area of skin superficial to it or otherwise in nervous relation to it. If a second or "counter" seat of "irritation" is set up, it will relieve the deeper and more vital part. We may conclude with respect to this theory:—

1. That rubefacients and vesicants will afford relief to the circulation of diseased parts in *immediate vascular connection* with the selected area, by attracting blood and draining off plasma from them. Thus a blister on the chest will relieve congested vessels in the parietal pleura. A secondary effect of the vascular disturbance will be to depress the general circulation, to diminish visceral congestion or inflammation, and to unload the heart.

2. That the irritation of the cutaneous nerves will also modify the circulation and nutrition of the immediately subjacent parts *in a reflex way*, the impression which passes in being reflected through the vaso-motor and trophic centres in the cord and brain.

3. That when the irritation of the local nerves and vessels thus affects the vaso-motor and trophic centres presiding over the area of skin, this disturbance may spread to a neighbouring *or otherwise related trophic centre* (say that of a joint), and thus produce a change in the nutrition of the deeper tissues, although itself but superficial.

4. That when a new seat of pain or other irritation is set up in a part of the surface of the body whose sensory fibres pass *through the segment corresponding with the sensory sympathetic fibres of the diseased viscus* (the posterior root

ganglion), the segment may be sufficiently disturbed to profoundly alter *painful or other morbid impulses* proceeding from the viscus or the reflected effects of these. And further,

5. That just as disease of an internal organ may produce herpes in an associated cutaneous area by disturbing the corresponding posterior root ganglion, so inflammatory counter-irritation (*e.g.* vesication) of a cutaneous area may *alter the nutrition of an associated internal organ*, and possibly modify disordered function or disease of it in a favourable way.

6. That *the production of exudate or pus* (*phagocytes*) by vesicants and pustulants antagonises in the blood or tissues the organised or other poisons which are the cause of the disease.

III. PATHOLOGICAL RELATIONS AND THERAPEUTICS.—The pathological conditions which we seek to influence by counter-irritants belong to various systems, which have been already studied. The same remark holds true of the therapeutical applications of the principles just examined. All that remains to be done here is to enumerate the chief morbid conditions which may be treated by counter-irritation. These are: (1) Subacute and chronic inflammation, with or without unnatural growth, of parts in direct vascular connection with the skin; such as the pleuræ and joints. (2) Congestion and inflammation in neighbouring viscera; for example, the lungs. (3) Pain in deep or distant parts, such as neuralgia, myalgia, and cardiac and renal pain. (4) Spasm and other motor disturbances in deep muscular structures, like lumbago, vomiting and syncope. (5) Central nervous disorders, such as hysteria.

B. Baths and Allied Measures.

The principles on which the use of baths depends are in a great measure identical with those which we have already discussed, and do not require to be repeated. If the student will carefully bear in mind the relations of the vessels and nerves of the skin to the body-heat, circulation generally, and nervous system, he will readily appreciate the subject of baths from the following tables, which give a list of the most common baths, together with their action and principal uses succinctly arranged.

I. Water Baths

Name	Temperature Fahr.	Actions	Uses
Cold	32° to 60°	Cools blood in cutaneous vessels; stimulates heart, respiration, etc., reflexly. Temporarily overfills internal vessels, thus raising blood-pressure.	Refrigerant in fever. Refreshing: the morning bath.
Cool	60° ,, 70°	The same, but less marked.	The same in weaker subjects.
Tepid	85° ,, 95°	Detergent (cleansing), physically and chemically; soothes the nerves.	Ordinary personal cleanliness. Allays restlessness of fever and lowers temperature.
Warm	95° ,, 100°	Raises local temperature; dilates the local vessels; stimulates glands, increasing discharge of warm secretions, and evaporation; soothes the nerves and the corresponding centres.	Diaphoretic in fever; diaphoretic in uræmia; anodyne; antispasmodic.
Hot	100° ,, 106°	The same, but more marked.	The same, but is more powerful.
,, Local	,, ,,	Attracts blood *to* part bathed.	To stimulate menstrual flow.
,, ,,	,, ,,	Attracts blood *from* distant parts.	To relieve internal congestions, as in catarrh and cerebral hæmorrhage.

II. Vapour Baths

Name	Temperature Fahr.	Actions	Uses
Simple Vapour or Russian	95° to 110°	Much like the warm- or hot-water bath, but slower, and at higher temperature.	Much like the warm-water-bath. A powerful diaphoretic.
Medicated watery vapour	,, ,,	The action chiefly of aromatics, *e.g.* pine.	Stimulant and antispasmodic.
Fumigations	Various.	Specific — Mercury, Sulphur, etc.	Specific.

III. AIR BATHS

NAME	TEMPERATURE FAHR.	ACTIONS	USES
Hot-air, or Turkish	Up to 220°, followed by cold.	Diaphoretic, followed by stimulation; anodyne; increases metabolism.	Like warm water and Russian baths. Tonic.
Electric-heat	Up to 300°.	Ditto.	Ditto.
Compressed-air	Ordinary.	Increases oxygenation.	Diseases of the lungs and heart.

IV. MEDICATED BATHS

NAME	TEMPERATURE FAHR.	ACTIONS	USES
Natural	That of the spring.	Specific.	Gout, rheumatism, syphilis, skin diseases, etc.
Sea	Various.	Stimulant.	Invigorating.
Artificial	Various.	Specific, *e.g.*, Nitro-hydrochloric Acid, Potassium Sulphide, and Mercurial solutions.	In hepatic diseases, rheumatism, syphilis, plumbism, and scabies and other skin diseases.

V. ELECTRIC WATER-BATHS

NAME	TEMPERATURE FAHR.	ACTIONS	USES
Galvanic Current baths	97°	Nervo-muscular stimulant.	Paralysis, neuritis.
Sinusoidal Current baths	97°	Metabolic stimulant and tonic.	Paralysis, toxic neuritis, gout.
Electrolytic	97°	Deposition of nascent elements.	Skin diseases, gout, rheumatism.

VI. ELECTRIC LIGHT BATHS

NAME	TEMPERATURE FAHR.	ACTIONS	USES
Radiant heat (Electric Light baths).	100° or lower	Quickly and powerfully diaphoretic, followed by stimulation; anodyne; increases metabolism, with local erythema and consequent desquamation.	Muscular rheumatism, neuritis, gout, chronic rheumatism, uræmia.

VII. Nauheim Baths

Name	Temperature Fahr.	Actions	Uses
Nauheim baths (Saline and Carbonic Acidbaths)	95° or less	Stimulate the skin; dilate the capillaries; area of præcordial dulness diminished; apex-beat moved inwards.	Cardiac degenerations and dilatation.

VIII. Complex Baths

Name	Temperature Fahr.	Actions	Uses
Mercurial and vapour	Sufficient to vaporise water and mercurial.	Specific.	Syphilis.
Mercurial and hot-air	Sufficient to vaporise mercurial.	Specific.	Syphilis.
Mud, pine, bran, etc.		Various.	Various.

The cold bath in fever.—A simple tepid-water bath is prepared, at a temperature of about 90°; the patient is carefully placed in it; and cold water is added until the thermometer in it falls to 80° or even 40°, according to circumstances. Here the patient remains for 10 to 20 minutes, his temperature being taken during immersion; or if any shivering occurs, he is at once removed. He is then wiped dry, placed in bed, and covered with blankets. A stimulant may be required. The cold bath may be repeated several times a day, if indicated.

In very urgent or desperate cases the cold bath may be increased in activity by lowering the temperature to freezing-point by ice and by prolonged immersion, even to three hours. This treatment requires great care and judgment.

The douche, affusion and shower bath.—The stimulant action of water may be greatly increased by directing it against the body in a single or divided stream. The size, height, direction and temperature of the stream, and the part and extent of surface to which it is applied, have great influence upon the effect of the douche. The *uses* of the shower bath are chiefly in hysteria and mania; of the local

douche in loss of sensibility of parts, chronic enlargements of joints or bones, and sprains. Affusion is of value in convulsions, sunstroke, mania and hysteria; and as a means of resuscitation.

The Wet-pack.—Prepare a bed by spreading a mackintosh and a blanket on the mattress and over the pillow of an ordinary single bedstead. Thoroughly wet a linen sheet with cold water, and spread it smoothly over the blankets. Strip the patient, place him flat on his back on the wet sheet with his head on the pillow, and envelop him in the sheet and blankets, by bringing these, one side at a time, across his body, and tucking them under the opposite side and under the heels. Finally cover him with several more blankets, and again tuck these closely round him. The ordinary duration of packing is a quarter of an hour to an hour. The pack is then removed, and the skin rubbed with a dry towel. The pack may be repeated several times a day if necessary.

The sense of chilliness produced by the wet sheet is quickly replaced by a delightful glow. The first action of the wet-pack is chiefly on the refrigerating function of the skin; heat is abstracted so that the temperature quickly falls. At the same time the frequency and force of the pulse decline; the central nervous system is soothed through the nerves, through the circulation, and by the refrigeration; and any pain, irritability or delirium that may be present is dispelled, so that sleep often is induced. The second effect of the wet-pack is diaphoresis, which may be profuse, the body being practically in a vapour bath.

The *uses* of the wet pack are, first, as a refrigerant in fevers, such as scarlatina and typhoid, when pyrexia is excessive, delirium high and the rash ill-developed; and, second, as a diaphoretic in threatening or actual uræmia, where hot instead of cold water is used, and its effect often is invaluable.

C. The Treatment of Wounds.

1. **Antiseptics and Aseptics** prevent putrefaction in a wound by virtue of their action in arresting the growth of organisms, or destroying these or the chemical activity of certain substances which give rise to fermentation and decomposition. They include: Carbolic Acid, Sulpho-carbolates, Creosote and Guaiacol; Boric Acid; Iodoform, Iodine; Eucalyptus, Thymol; Salicylic Acid, Quinine; Sulphurous Acid; Mercuric Chloride, Mercury Biniodide and Cyanide; Zinc Chloride; Silver Nitrate, Alcohol, Formalin, Potassium Permanganate, Turpentine, Hydrogen Peroxide, Balsam of Peru, and others.

2. **Disinfectants** are substances which destroy micro-organisms or active chemical substances and their products on surfaces already foul or infected. They are for the most part the same materials as the antiseptics, but are employed in a much stronger form. Such are strong solutions of Zinc Chloride and Carbolic Acid, Iodoform, Iodine, Sulphurous Acid and Hydrogen Peroxide. Some forms of electrical radiation, such as the Roentgen rays and the ultra-violet rays (Finsen's), as well as the high frequency current, are also germicides.

3. **Deodorants** absorb gases and neutralise foul odours. Those chiefly used are Potassium Permanganate and Iodoform.

4. **Astringents** coagulate or precipitate the albuminous discharges, coagulate the germinal protoplasm of the upper layers of cells, and either directly contract or indirectly constringe the vessels so as to limit exudation. They are used to check excessive discharge and granulation growth in wounds and ulcers. Astringents include: Solutions of Silver Nitrate, Lead Subacetate and Acetate, Zinc Sulphate, Copper Sulphate, Alum, Ferric Salts, Tannic Acid and its allies, and Phenol.

5. **Stimulants** are for the most part mild astringents, applied chiefly in the form of lotion; such as weak solutions of Silver Nitrate, Copper Sulphate, Zinc Sulphate, Phenol, etc. They are more efficacious as weak spirituous solutions. Stimulants are used to wounds when healing flags or the granulations tend to become prominent.

6. **Styptics** are applied to wounds to check hæmorrhage (see page 553). They include: Supra-renal Body, Ice, Ferric Salts, Silver Nitrate, and Tannic Acid in its many forms.

7. **Caustics and Escharotics** are intended to destroy part of the living tissues, and thus arrest the activity of organic poisons, as in bites, dissection wounds, syphilis, malignant disease and gangrenous processes. They include: Caustic Alkalis, Mineral Acids, Zinc Chloride, Silver Nitrate, Copper Sulphate, Arsenious Acid, Acid Solution of Mercuric Nitrate, Exsiccated Alum and pure Carbolic Acid.

8. **Vesicants** are applied to chronic ulcerating surfaces to stimulate the circulation in the surrounding parts, and soften callous edges. Cantharides and Mylabris are chiefly used.

9. **Anodynes** are intended to alleviate the pain of wounds and ulcers and to induce sleep. The medicinal anodynes commonly thus applied are preparations of Opium and Belladonna.

Substances which act upon the Pupil

Pupil Dilators: Mydriatics	Pupil Contractors: Myotics
Belladonna, Atropina	Physostigma, Eserina
Stramonium, Hyoscyamus, Hyoscyamina, Duboisina	Jaborandi, Pilocarpina
Homatropina	Opium, Morphina
Gelsemium	Chloroformum (2nd Stage)
Cocaina	
Chloroformum (1st and 3rd Stages)	

Substances which act upon the Generative Organs

Substances which stimulate the non-gravid Uterus: Emmenagogues	Substances which stimulate the Gravid Uterus: Ecbolics: Oxytocics	Substances which depress the Uterus
Myrrha	Ergota	Bromides
Aloes	Gossypii Radicis Cortex	Opium
Ergota	Pilocarpina	Chloral Hydras
Alcohol	Drastic Purgatives	Cannabis Indica
Cantharis	Borax	Chloroformum
Digitalis	Plumbum	Antimonium Tartaratum
Cimicifuga		Cupri Sulphas
Gossypii Rad. Cortex		Emetics
Purgatives		Viburnum
Hæmatinics		
Tonics		

Substances which stimulate the Sexual Organs: Aphrodisiacs	Substances which depress the Sexual Organs: Anaphrodisiacs
Camphora (at first)	Bromides
Opium ,,	Camphora (at last)
Cannabis Indica	Opium ,,
Nux Vomica, Strychnina	Belladonna
Phosphorus	Hyoscyamus
Cantharis	Stramonium
Alcohol	Circulatory Depressants
Lupulus	
Hæmatinics	
Tonics	

CLASSIFIED TABLES OF THE PHARMACEUTICAL PREPARATIONS OF THE BRITISH PHARMACOPŒIA.

Aceta. — Cantharidis, Ipecacuanhæ, Mylabridis, Scillæ, Urgineæ.

Aquæ.—Anethi, Anisi, Aurantii Floris, Camphoræ, Carui, Chloroformi, Cinnamomi, Destillata, Fœniculi, Laurocerasi, Menthæ Piperitæ, Menthæ Viridis, Pimentæ, Rosæ, Sambuci.

Charta.—Sinapis.

Confectiones.—Piperis, Rosæ Gallicæ, Sennæ, Sulphuris

Decocta.—Acaciæ Corticis, Agropyri, Aloes Compositum, Cissampeli, Gossypii Radicis Corticis, Granati Corticis, Hæmatoxyli, Hydrophylæ, Ispaghulæ, Sapan.

Emplastra.—Ammoniaci cum Hydrargyro, Belladonnæ, Calefaciens, Calefaciens Mylabridis, Cantharidis, Hydrargyri, Menthol, Mylabridis, Opii, Picis, Plumbi, Plumbi Iodidi, Resinæ, Saponis.

Extracta :

1. *Extracts* (simple).—Aloes Barbadensis, Anthemidis, Cannabis Indicæ, Cascaræ Sagradæ, Colchici, Ergotæ, Gentianæ, Glycyrrhizæ, Jalapæ, Krameriæ, Nucis Vomicæ, Opii, Physostigmatis, Rhei, Stramonii, Strophanthi, Taraxaci.
2. *Alcoholic Extract.*—Belladonnæ Alcoholicum.
3. *Dry Extract.*—Euonymi.
4. *Compound Extract.*—Colocynthidis Compositum.
5. *Green Extracts.* — Belladonnæ Viride, Hyoscyami Viride.
6. *Liquid Extracts.*—Acalyphæ Liquidum, Adhatodæ Liquidum, Agropyri Liquidum, Belæ Liquidum, Belladonnæ Liquidum, Cascaræ Sagradæ Liquidum, Cimicifugæ Liquidum, Cinchonæ Liquidum, Cissampeli Liquidum, Cocæ Liquidum, Ergotæ Liquidum, Filicis Liquidum, Glycyrrhizæ Liquidum, Gossypii

Radicis Corticis Liquidum, Grindeliæ Liquidum, Hamamelidis Liquidum, Hydrastis Liquidum, Ipecacuanhæ Liquidum, Jaborandi Liquidum, Kavæ Liquidum, Nucis Vomicæ Liquidum, Opii Liquidum, Pareiræ Liquidum, Picrorhizæ Liquidum, Sarsæ Liquidum, Taraxaci Liquidum, Viburni Prunifolii Liquidum.

7. *Spirituous Extract.*—Glycyrrhizæ Spirituosum.

Glycerina.—Acidi Borici, Acidi Carbolici, Acidi Tannici, Aluminis, Amyli, Boracis, Pepsini, Plumbi Subacetatis, Tragacanthæ.

Infusa.—Alstoniæ, Andrographadis, Azadivachdiæ Indicæ, Aurantii, Aurantii Compositum, Buchu, Calumbæ, Caryophylli, Cascarillæ, Chiratæ, Cinchonæ Acidum, Coscinii, Cuspariæ, Digitalis, Ergotæ, Gentianæ Compositum, Krameriæ, Lupuli, Quassiæ, Rhei, Rosæ Acidum, Scoparii, Senegæ, Sennæ, Serpentariæ, Tinosporæ, Toddaliæ, Uvæ Ursi.

Injectiones Hypodermicæ.—Apomorphinæ, Cocainæ, Ergotæ, Morphinæ.

Lamellæ.—Atropinæ, Cocainæ, Homatropinæ, Physostigminæ.

Linimenta.—Aconiti, Ammoniæ, Belladonnæ, Calcis, Camphoræ, Camphoræ Ammoniatum, Chloroformi, Crotonis, Hydrargyri, Opii, Potassii Iodidi cum Sapone, Saponis, Sinapis, Terebinthinæ, Terebinthinæ Aceticum.

Liquores. — Acidi Chromici, Ammoniæ, Ammoniæ Fortis, Ammonii Acetatis, Ammonii Citratis, Arsenicalis, Arsenici Hydrochloricus, Arsenii et Hydrargyri Iodidi, Atropinæ Sulphatis, Bismuthi et Ammonii Citratis, Calcis, Calcis Chlorinatæ, Calcis Saccharatus, Caoutchouc, Epispasticus, Epispasticus Mylabridis, Ethyl Nitritis, Ferri Acetatis, Ferri Perchloridi, Ferri Perchloridi Fortis, Ferri Pernitratis, Ferri Persulphatis, Hamamelidis, Hydrogenii Peroxidi, Hydrargyri Nitratis Acidus, Hydrargyri Perchloridi, Iodi Fortis, Magnesii Carbonatis, Morphinæ Acetatis, Morphinæ Hydrochloridi, Morphinæ Tartratis, Pancreatis, Picis Carbonis, Plumbi Subacetatis Fortis, Plumbi Subacetatis Dilutus, Potassæ, Potassii Permanganatis, Sodæ Chlorinatæ, Sodii Arsenatis, Sodii Ethylatis, Strychninæ Hydrochloridi, Thyroidei, Trinitrini, Zinci Chloridi.

Liquores Concentrati. — Andrographidis, Aristolochiæ, Berberidis, Calumbæ, Chiratæ, Coscinii, Cuspariæ, Krameriæ, Quassiæ, Rhei, Sarsæ Compositus, Senegæ, Sennæ, Serpentariæ, Tinosporæ, Todaliæ.

Lotiones.—Hydrargyri Flava, Hydrargyri Nigra.

Mella.—Boracis ; Oxymel, Oxymel Scillæ, Urgineæ.

Misturæ.—Ammoniaci, Amygdalæ, Creosoti, Cretæ, Ferri Composita, Guaiaci, Olei Ricini, Sennæ Composita, Spiritus Vini Gallici.

Mucilagines.—Acaciæ, Gummi Indici, Tragacanthæ.

Oleum.—Phosphoratum.

Pilulæ.—Aloes Barbadensis, Aloes et Asafetidæ, Aloes et Ferri, Aloes et Myrrhæ, Aloes Socotrinæ, Cambogiæ Composita, Colocynthidis Composita, Colocynthidis et Hyoscyami, Ferri, Galbani Composita, Hydrargyri, Hydrargyri Subchloridi Composita, Ipecacuanhæ cum Scilla, Ipecacuanhæ cum Urginea, Phosphori, Plumbi cum Opio, Quininæ Sulphatis, Rhei Composita, Saponis Composita, Scammonii Composita, Scillæ Composita, Urgineæ Composita.

Pulveres.—Amygdalæ Compositus, Antimonialis, Catechu Compositus, Cinnamomi Compositus, Cretæ Aromaticus, Cretæ Aromaticus cum Opio, Elaterini Compositus, Glycyrrhizæ Compositus, Ipecacuanhæ Compositus, Jalapæ Compositus, Kaladanæ Compositus, Kino Compositus, Opii Compositus, Rhei Compositus, Scammonii Compositus, Sodæ Tartaratæ Effervescens, Tragacanthæ Compositus.

Spiritus.—Ætheris, Ætheris Compositus, Ætheris Nitrosi, Ammoniæ Aromaticus, Ammoniæ Fetidus, Anisi, Armoraciæ Compositus, Cajuputi, Camphoræ, Chloroformi, Cinnamomi, Juniperi, Lavandulæ, Menthæ Piperitæ, Myristicæ, Rectificatus, Rosmarini, Vini Gallici.

Succi.—Acalyphæ, Adhatodæ, Belladonnæ, Conii, Hyoscyami, Scoparii, Taraxaci.

Suppositoria.—Acidi Carbolici, Acidi Tannici, Belladonnæ, Glycerini, Iodoformi, Morphinæ, Plumbi Compositum.

Syrupi.—Syrupus ; Aromaticus, Aurantii, Aurantii Floris, Calcii Lactophosphatis, Cascaræ Aromaticus, Chloral, Codeinæ, Ferri Iodidi, Ferri Phosphatis, Ferri Phosphatis cum Quinina et Strychnina, Glucosi, Hemidesmi, Limonis, Pruni Virginianæ, Rhei, Rhœados, Rosæ, Scillæ, Sennæ, Tolutanus, Urgineæ, Zingiberis.

Tabellæ.—Trinitrini.

Tincturæ: 1. *Simple Tinctures.*—Aconiti, Adhatodæ, Aloes, Alstoniæ, Andrographidis, Aristolochiæ, Arnicæ, Arnicæ Florum, Asafetidæ, Aurantii, Azadirachtæ Indicæ, Belladonnæ, Berberidis, Buchu, Calotropis, Calumbæ, Cannabis Indicæ, Cantharidis, Capsici, Cascarillæ, Catechu, Chiratæ, Chloroformi et Morphinæ, Cimicifugæ, Cinchonæ, Cinnamomi, Cocci, Colchici Seminum, Conii,

Coscinii, Croci, Cubebæ, Daturæ Seminum, Digitalis, Ferri Perchloridi, Gelsemii, Hamamelidis, Hydrastis, Hyoscyami, Iodi, Jaborandi, Jalapæ, Kaladanæ, Kino, Krameriæ, Limonis, Lupuli, Myrrhæ, Nucis Vomicæ, Oliveri Corticis, Opii, Picrorhizæ, Podophylli, Podophylli Indici, Pyrethri, Quassiæ, Scillæ, Senegæ, Serpentariæ, Stramonii, Sumbul, Tinosporæ, Tolutana, Urgineæ, Zingiberis.

2. *Ammoniated Tinctures.*—Ergotæ Ammoniata, Guaiaci Ammoniata, Opii Ammoniata, Quininæ Ammoniata, Valerianæ Ammoniata, Valerianæ Indicæ Ammoniata.
3. *Ethereal Tincture.*—Lobeliæ Ætherea.
4. *Compound Tinctures.*—Benzoini Composita, Camphoræ Composita, Cardamomi Composita, Cinchonæ Composita, Gentianæ Composita, Jalapæ Composita, Lavandulæ Composita, Rhei Composita, Sennæ Composita.

Trochisci.—Acidi Benzoici, Acidi Carbolici, Acidi Tannici, Bismuthi Composita, Catechu, Eucalypti Gummi, Ferri Redacti, Guaiaci Resinæ, Ipecacuanhæ, Krameriæ, Krameriæ et Cocainæ, Morphinæ, Morphinæ et Ipecacuanhæ, Potassii Chloratis, Santonini, Sodii Bicarbonatis, Sulphuris.

Unguenta.—Acidi Borici, Acidi Carbolici, Acidi Salicylici, Aconitinæ, Aquæ Rosæ, Atropinæ, Belladonnæ, Cantharidis, Capsici, Cetacei, Chrysarobini, Cocainæ, Conii, Creosoti, Eucalypti, Gallæ, Gallæ cum Opio, Glycerini Plumbi Subacetatis, Gynocardiæ, Hamamelidis, Hydrargyri, Hydrargyri Ammoniati, Hydrargyri Compositum, Hydrargyri Iodidi Rubri, Hydrargyri Nitratis, Hydrargyri Nitratis Dilutum, Hydrargyri Oleatis, Hydrargyri Oxidi Flavi, Hydrargyri Oxidi Rubri, Hydrargyri Subchloridi, Iodi, Iodoformi, Mylabridis, Myrobalani, Myrobalani cum Opio, Paraffini, Picis Liquidæ, Plumbi Acetatis, Plumbi Carbonatis, Plumbi Iodidi, Potassii Iodidi, Resinæ, Staphisagriæ, Sulphuris, Sulphuris Iodidi, Veratrinæ, Zinci, Zinci Oleatis.

Vina.—Antimoniale, Aurantii, Colchici, Ferri, Ferri Citratis, Ipecacuanhæ, Quininæ.

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