PRACTICAL VETERINARY PHARMACOLOGY AND THERAPEUTICS

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Practical Veterinary Pharmacology and Therapeutics

BY

HOWARD JAY MILKS, D.V.M.

Professor of Therapeutics and Small Animal Clinic, New York State Veterinary College at Cornell University, Ithaca, N. Y.

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PREFACE

This book is intended for a practical text on Veterinary Materia Medica, Pharmacology and Therapeutics. The author realizes that the only object of studying pharmacology is the use of drugs in treating disease, yet, in order to prescribe a drug intelligently it is necessary to have more than a general idea of its action. The greater emphasis is placed upon pharmacology because the author believes that the only place to study Materia Medica is in the laboratory and Therapeutics can best be studied in medicine and the clinics.

There are numerous ways in which remedies may be grouped and none is perfect although it seems that a therapeutic grouping has many advantages since it allows a better correlation between the action and the uses of the different agents. Consequently the plan has been to discuss the different groups in a general way and then follow with a detailed description of the individual drugs.

The prescriptions are intended only to be representative and to illustrate the ways in which medicines may be prescribed, although many of them have been tried and are in almost daily use by the author.

The author claims little if any originality in the material included. He has drawn freely from the current literature and standard books on the subject. He has not considered it wise to include a bibliography in a book of this kind. Yet he would especially desire to mention such books as those of Cushny, Sollmann, Bastedo, Dixon, Hoare and Fröhner on pharmacology and therapeutics; those of Law and Hutyra and Marek on medicine and Arny on pharmacy. In conclusion I desire to express my appreciation to Dr. C. P. Fitch for the most excellent chapter on Bacterius, Serums, Vaccines and antitoxins, and to Prof. P. A. Fish for the use of several tracings.

H. J. M.

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PRACTICAL VETERINARY PHARMACOLOGY AND THERAPEUTICS

CHAPTER I

DEFINITIONS

The terms Materia Medica, Pharmacognosy, Pharmacographia, Pharmacology and Pharmaco-dynamics used in the same general way have the same meaning. They may be broadly defined to cover all scientific knowledge concerning drugs. If it is desired to limit the meaning of the terms more specifically, they may be differentiated as follows:

1. **Materia Medica** (Pharmacographia) deals with the physical and chemical properties of drugs, their sources, history, anatomy, pharmaceutic preparations and doses.

(a) *Organic Materia Medica* was a term formerly used to designate drugs obtained from the vegetable kingdom.

(b) *Inorganic Materia Medica* was likewise used to designate those derived from the mineral kingdom.

2. **Pharmacology** (Pharmaco-dynamics) treats of the action of drugs upon living organisms.

3. **Pharmacy** is the science and art of preparing, compounding and dispensing drugs. It includes metrology (Weights and Measures), manufacture and dispensing.

4. **Toxicology** is the science which deals with the detection of poisons, their symptoms and treatment or antidotes.

5. **Therapeutics** is that subject which deals with the methods used in the cure or alleviation of disease. In other words it is the application of pharmacology or materia medica and other sciences to the treatment of disease.

A drug is any substance other than a food stuff or mechanical agent that produces change in a living organism. If used in doses suitable to produce beneficial effects, it is a *Medicine,* but if the dose is sufficiently large to produce harmful effects, it is a *Poison.*

SOURCE AND COMPOSITION OF DRUGS

Drugs are obtained from both *organic and inorganic substances.* The vegetable and biological preparations are obtained from the former, while the various metals and their salts, the composition of

which is shown by their names and chemical formulæ, are obtained from the inorganic. The greater number, probably, are derived from the vegetable kingdom or from plants. All the different parts of a plant may be used in medicine but the active principle to which the action of each is due is usually found more abundantly in certain parts than others. In such cases the part or parts containing the largest amounts are used. The active principle may, however, be quite evenly diffused throughout, in which case the entire plant may be used.

GROSS ANATOMY OF PLANTS

Underground Portions. These include the root, rhizome, tuber, bulb and corm. The root is that portion usually without chlorophyll which does not have power to produce leaves. Roots sometimes possess a bark which is used separately (Sassafras). Rhizomes are the underground portions capable of producing leaves (Hydrastis). A tuber is a portion of the root greatly thickened which serves for the accumulation of reserve food materials (Aconite). A bulb is an increase in size of the root leaves (Onion, squill), while a corm is the thickened lowest part of the stem (Colchicum).

Portions above Ground. If the entire plant above ground is used, it is termed herb (Herba, Species) and consists of the leaves, stems, and sometimes of the flowers and fruit.

Stem. In herby plants it is termed stipes, in larger plants it is transformed into wood (Lignum) and covered with a bark (cortex). The leaves (folia) consist of a leaf stem (petiolus) and blade (lamina). There are also the flowers (flores), and fruit (fructus) or seed (semenis). Besides the above, certain drugs consist of the juices of plants and are without definite structure (Opium, aloes).

CHEMISTRY OF PLANTS

The chief elements found in plants are Carbon, Hydrogen, Oxygen and Nitrogen. These elements usually occur in combinations as fats, carbohydrates, tannins, resins, alkaloids, glucosides, acids, terpenes, etc., together with inorganic salts.

ALKALOIDS

Many of the most important and active plant constituents are alkaloids. They may exist in almost any part of the plant but are frequently found in the largest proportions in the seed and roots. They represent, in the greater number of cases, the active principle of the plant from which they are obtained and many of them are classed with the most powerful poisons.

Definition. Alkaloids may be defined as natural-nitrogenous organic bases, i.e., they are organic substances containing nitrogen,

of basic character, uniting with acids without the elimination of hydrogen, forming well defined and usually crystalline salts. The alkaloidal salts of the halogens are called the hydrobromides, hydrochlorides, etc., not the bromides, chlorides, etc. They contain nitrogen, carbon, hydrogen, and most of them oxygen. Those containing oxygen are solids and comparatively non volatile (cocaine), while those which do not contain oxygen are liquids and volatile (nicotine).

Characteristics. All alkaloids have certain characteristics: Bitter taste, alkaline reaction to litmus, strong physiological reaction and cause no post mortem changes. The pure alkaloids differ from their salts in solubility. The alkaloids are freely soluble in chloroform, ether, and oils, less soluble in alcohol and almost insoluble in water, while the salts behave almost exactly opposite, being soluble in water and alcohol and almost insoluble in chloroform, ether and oils.

Nomenclature. The United States Pharmacopœia makes all the names of alkaloids end in *ine* (Latin, ina) as quinine (quinina), morphine (morphina), to distinguish them from the neutral principles ending in *in* (Latin, inum) as digitalin (digitalinum), santonin (santoninum). This is a very simple way in which to distinguish these principles, and it is to be regretted that this distinctive spelling is not followed in all text-books.

Incompatibles. Alkaloids are incompatible with many substances and it is necessary to know the chief substances with which they are incompatible in order to prescribe them intelligently. The most common incompatibles are:

1. *Alkalies* which combine with the acid radicle and throw down the less soluble pure alkaloids as a precipitate, while some alkaloids are destroyed by strong alkalies.
2. *Tannic Acid* which forms comparatively insoluble tannates.
3. *Iodine, Iodides and Bromides* which form comparatively insoluble iodides, bromides or double salts.
4. *Mercuric Chloride* which forms insoluble double salts.

In all the above cases, the alkaloids are simply rendered less soluble in water, and if a large volume of water or fair percentage of alcohol is present, the precipitation will not occur.

Besides the alkaloids there are several other active principles of plants which should be mentioned. Those with neither acid nor basic characters are called "neutral principles." If they are not very poisonous and have a very bitter taste, they are termed "bitter principles." They differ from glucosides in not being converted into glucose and from alkaloids in not being precipitated by tannin or mercuric potassium iodide.

Glucosides are those principles or substances derived from plants which when treated with dilute acids or submitted to the action of ferments split into glucose as one of the decomposition products.

They do not all contain nitrogen. A few are alkaloidal, but most are neutral.

Resins are solid plant substances or exudations usually acid in character, insoluble in water, soluble in water and an alkali. The definition of the pharmaceutic class —"resins"— is those plant products soluble in alcohol and insoluble in water, obtained either as a residue from the distillation of an oleoresin or by pouring a concentrated alcoholic extract of the drug into water or acidulated water.

If they occur mixed with a volatile oil they are termed oleoresins.

Gum Resins are mixtures of a gum and a resin or oleoresin.

Gums are desiccated exudations obtained by incising the limbs and branches of certain plants. They form a mucilage or jelly with water, and are insoluble in alcohol. The most important are acacia and tragacanth.

Balsams are natural products differing from oleoresins in containing benzoic or cinnamic acids to which the delightful odor is due. Chief are Tulu and Peru.

Resinoids are principles soluble in alcohol, insoluble in water. They are often mixtures containing true resins.

Oils. These occur as fixed and volatile or essential. An oil is a substance which greases, which leaves when dropped on a cloth a stain which water will not wash out, a stain which makes paper translucent. They are termed fixed or volatile, according to the permanency of this stain on warming, characters clearly defined by the names given the two groups. If a drop of the oil is placed upon paper and warmed over a flame, the stain disappears if it is a volatile oil, while if a fixed oil, the stain remains. A very simple test is the action of a ground glass stopper of a bottle containing the oil. The stopper of a bottle of fixed oil rotates easily and quietly in the neck, whereas a volatile oil stopper, when rotated in the neck, makes a squeaking noise.

Volatile oils are odorous principles, of the physical characteristics of fixed oils, from which they differ by being soluble in alcohol and by being volatile. To them is due the odor of plants. Volatile oils are called essential oils from the fact that they possess, in a concentrated state, the properties of plants from which they are obtained. They are mixtures of a number of substances and it so happens in some cases that some of the substances are solids dissolved in the liquid portion. These solids may sometimes be removed by chilling the oil in a freezing mixture and draining off the unfrozen part (the *eleopten*), leaving the solid part or *stearopten*. In other words stearoptens are the solid portions of volatile oils. Examples: Camphor, Menthol, Thymol.

Saponins and Sapotoxins are neutral nonnitrogenous bodies characterized by foaming with water, emulsifying fats, and laking red blood cells. A few are glucosides. The former term is given to

the less poisonous, and the latter to the more poisonous of the group.

Besides the previously mentioned substances the juice of plants contains many other substances, such as alcohols, aldehydes, ethers, acids, aromatic bodies, coloring matter and a certain amount of mineral matter.

CHAPTER II

PHARMACY

PHARMACY is the science and art of preparing, compounding and dispensing drugs. The objects of pharmacy are so obvious that they need not be pointed out in this place. In order to have uniformity in the preparations obtained from the different shops, practically all civilized countries have standards, established by law, to which the drugs and their preparations must conform.

Pharmacopœia. The books in which these standards are given are usually called pharmacopœias. The first pharmacopœia of the United States was published in 1820 and is revised every ten years by a committee of physicians and pharmacists. The preparations made according to this book are called official. The present Ninth Decennial revision appeared in August and became official in September, 1916. The pharmacopœia gives, first, the Latin title of the drug, followed by the English name, official abbreviation and synonyms. A short concise definition of the drug is given. This is followed by the characteristics and tests by which the identity and purity of the drug may be recognized and finally in what doses (human) it may be administered.

Since the pharmacopœia is intended as a concise standard work of reference, it does not include all the material used in medicine nor does it go into detail concerning the drugs treated. Consequently in various countries other books have come into use, namely, dispensatories.

Dispensatories are commentaries on the pharmacopœia. They contain all that the pharmacopœia states regarding official drugs and much added information. They also treat of other drugs not mentioned in the pharmacopœia. There are three in the U. S.: — The National, United States and King's dispensatories.

In addition to the above books, there is the National Formulary, which contains formulæ not included in the pharmacopœia, but of sufficient importance to render standardization desirable. It is published by the American Pharmaceutical Association. Preparations made according to this book are generally designated as, *N. F.* They were recognized as official by the National Pure Drug Act passed June 30, 1906.

METROLOGY—WEIGHTS AND MEASURES

Metrology is the science of weights and measures.

Weight is the sum of the attraction of gravity existing between the earth and a body upon its surface, and in weighing we simply balance a substance against another known force.

There are several standards of weights used in the United States, with which the physician, veterinarian and pharmacist must become familiar. Those most used are the Troy or Apothecaries' weights and the Wine or Apothecaries' measures, besides which are the Avoirdupois weights, and Metric weights and measures.

TABLE OF AVOIRDUPOIS WEIGHTS

437.5	grains (gr.)	= 1 ounce (oz.)
16	oz.	= 1 pound (lb.) = (7000 gr.)
100	lbs.	= 1 hundredweight (cwt.)
20	cwt.	= 1 ton

This table is never used in prescribing but is the one used almost exclusively in buying and selling all solid and many liquid drugs. When we purchase a "pound" we get an Avoirdupois pound, or 7000 grains. If we order an "oz.," we receive an Avoirdupois ounce or 437.5 grains, as oz. stands for Avoirdupois ounce only. Many powerful drugs, like strychnine, morphine, etc., are usually handled in ⅛ oz. bottles, but these do not contain ⅛ of an Apothecaries' ounce or 60 grains, but ⅛ of an Avoirdupois ounce or about 54.7 grains.

TABLE OF APOTHECARIES' OR TROY WEIGHTS

20	grains (gr.)	= 1 scruple (℈)
3	scruples	= 1 drachm (ʒ) = 60 gr.
8	drachms	= 1 ounce (℥) = 480 gr.
12	ounces	= 1 pound (℔) = 5760 gr.

The grain used in this system is the same as that of the Avoirdupois, but the ounces contain 480 grains against 437.5 of the Avoirdupois, while the pound, ℔. contains 12 ounces of 480 grains, or 5760 grains, instead of the Avoirdupois pound of 16 ounces of 437.5 each or 7000 grains.

Of this table only the grains, drachms and ounces should be used in prescription writing. The scruple was used at one time, but is largely in disuse at the present time and is unnecessary. Furthermore the character is not easily made, and if made carelessly or blurred may be mistaken for the drachm sign.

TABLE OF APOTHECARIES' (OR WINE) MEASURES

60	Minims (♏)	= 1 fluidrachm (f ʒ)	
8	Fluidrachms	= 1 fluidounce (f ℥)	480 ms.
16	Fluidounces	= 1 pint (O.)	7680 ms.
8	pints	= 1 gallon (Cong.)	61440 ms.

To avoid confusion in the use of the Apothecary and Avoirdupois systems, the symbols, ℔., ℥, ℨ, and ℈ should be consistently used for the apothecary and the abbreviations, lb., oz., gr., for the Avoirdupois. The abbreviation for the Troy pound is characterized by the cross line drawn through the letters, ℔., and should always mean 12 ounces, while the Avoirdupois pound stands for sixteen ounces. The symbol ℥ means an Apothecaries' ounce of 480 grains, while the abbreviation oz., means an Avoirdupois ounce of 437.5 grains. The grain weight is the same for both systems and therefore the abbreviation gr. will cause no confusion. The grain is, therefore, the unit for both systems and the term is derived from the old system of weighing, which required that there should be used a grain of wheat, well dried and from the middle of the ear (head).

The character f℥ represents 60 minims, and f℥ is necessary to represent 480 minims.

A minim of water weighs about one grain (0.95 gr.) but it should be remembered that a minim is not the equivalent of a grain. 480 minims (1f℥) of water weighed at the standard temperature of 25° C. (77° F.) weigh 454.6 grains. The specific gravity of liquids also varies so that a pint of liquid is not necessarily a pound. In writing the Apothecaries' weights and measures in prescriptions, the figures are written in the Roman system and placed after the symbol, as gr..XX not 20 grs. In printed matter the small letters are used, but in writing it is better to use the capital L, because the small letter might easily be mistaken for an i. The ones should always be dotted and the last one may be written like a j; thus ℥ iij. But under no circumstances should the other be dotted, because in a hastily written or blurred prescription the pharmacist often depends upon the dots to differentiate an indistinct i from an l or a comma or period, or from an imperfectly formed v. Fractions are written as common fractions: gr. $\frac{1}{10}$, not gr. 0.1. The f before the sign ℨ or ℥ is often omitted.

TABLE OF APPROXIMATE OR POPULAR MEASURES

The popular measures are those usually found in the household. They are very inexact, and should be replaced with measuring glasses or some other means of measure. A common method in veterinary medicine is to use homeopathic vials of certain capacities, or syringes of known capacity. If spoons are used they should be filled so that the fluid stands level with the rim.

The most common of these measures are:

1 drop (gtt.)	=	1 minim
1 teaspoonful	=	1 f℥
1 dessertspoonful	=	2 f℥
1 tablespoonful	=	4 f℥ (½℥)
1 wineglassful	=	2 f℥
1 teacupful	=	4 f℥
1 glassful	=	8 f℥

It should be kept in mind that these equivalents are only approximate. A drop is not a minim and varies greatly with the character of the fluid, and of the container from which dropped; there may be from 44 drops of syrup of acacia, to 250 drops of chloroform to the drachm. Teaspoons vary from ½ to 2 drachms, dessert spoons vary so greatly that they should not be used. Tablespoons, wineglasses and tumblers also vary.

It is usual in figuring prescriptions to figure from 6 to 8 teaspoonfuls to the ounce, a tablespoonful as one-half ounce and in writing prescriptions these factors should always be taken into account so that the druggist will be able to use a bottle which will hold just the amount desired. Their bottles are ½ ounce, one ounce, two, three, four, six, eight and sixteen ounces.

METRIC SYSTEM

This is based upon the decimal system. The unit of measure of distance of the metric system is the meter (M.) (39.37 inches). The meter is divided into 10, 100 and 1000 parts, called respectively, decimeter, dm.; centimeter, cm.; and millimeter, mm.

The unit of measure of capacity is the liter, l. It is equal to the contents of a cube whose edges measure a decimeter and the thousandth part of this is a milliliter (mil) formerly called a cubic centimeter (c.cm. or c.c.). The unit of weight is the Gramme (frequently written gram) which is the weight of one milliliter of water at 4° Centigrade (39.2° F.).

Greater or less quantities are designated by adding prefixes to the above.

TABLE OF METRIC WEIGHTS

1 milligram	=	0.001
10 milligrams	= 1 centigram (cg.)	0.01
10 centigrams	= 1 decigram (dg.)	0.1
10 decigrams	= 1 gram (gm.)	1.
10 grams	= 1 Dekagram (Dg.)	10.
10 Dekagrams	= 1 Hectogram (Hg.)	100.
10 Hectograms	= 1 Kilogram (Kg.)	1000.

TABLE OF METRIC MEASURES

1 milliliter (mil)	=	0.001
10 milliliters (mils)	= 1 centiliter (cl.)	0.01
10 centiliters	= 1 deciliter (dl.)	0.1
10 deciliters	= 1 Liter (L.)	1.
10 Liters	= 1 Dekaliter (DL.)	10.
10 Dekaliters	= 1 Hectoliter (HL.)	100.
10 Hectoliters	= 1 Kiloliter (KL.)	1000.

In the above tables of weights and measures, the kilogramme is used in commerce and is referred to as a Kilo. The gram, fractions

of a gram and milligrams are used. In the measures of quantity the Liter and milliliter and fractions of them are used.

In prescription writing only two units, grams and milliliters, are used, abbreviated gm. and mil. In expressing the quantity of drug in a prescription in the metric system, the quantity is always denoted by the Arabic figure placed before the appellation. Fractional parts are always converted into decimal fractions. It is not necessary to write grams, or milliliters or their abbreviations, in a prescription because it is understood that the former will be used as the unit of weight and the latter for the unit of measure.

TABLE OF APPROXIMATELY EQUIVALENT WEIGHTS AND MEASURES

1 milligram (mil)	0.001	=	1/64 grain
1 centigram	0.01	=	1/6 grain
1 decigram	0.1	=	1½ grains
1 gram	1.	=	15½ (15.432) grains
4 grams	(3.9)	=	1 drachm
31 grams	(31.1)	=	1 ounce
500 grams	(453.6)	=	1 pound (av.)
1 Kilogram		=	2.2 pounds (av.) (2.2946)

1/64 grain	=	.001 gram
1/6 grain	=	.01 gram
1 grain	=	0.065 gram
15 ½ (15.432) grains	=	1. gram
1 drachm (apoth.)	=	4. (3.9) grams
1 ounce (apoth.)	=	31.1 grams

1 minim	=	0.61 mil
16 minims (16.23)	=	1. mil
1 fluidrachm	=	3. 75 mils
1 fluidounce	=	30. (29.572) mils
1 pint	=	500. (.4731 L. or 473 mils

THE FOLLOWING TABLE OF APPROXIMATE EQUIVALENTS SHOULD BE MEMORIZED:

1 mil 1 gram	= 15–16 minims or grains
4 mils 4 grams	= 1 fluidrachm or drachm
30 mils 30 grams	= 1 fluidounce or ounce
500 mils 500 grams	= 1 pint or pound
1 Liter	= 1 quart
1 Kgm.	= 2.2 lbs.

To convert grains into centigrams, multiply by 6.5. Thus 3 grains multiplied by 6.5 equals 10.5 centigrams, or 10 grains equal 65 centigrams or .65 grams. To convert centigrams into grains, divide by 6.5. Thus 26 centigrams divided by 6.5 equals 4 grains.

WEIGHING

In weighing a body we simply balance the force it exerts by its gravity against another known force. There are several types of balances or scales,— spring, equal arm, unequal arm, and torsion. The first is not very exact but is handy for coarse weighing. In weighing small amounts delicate instruments should be used. A few simple rules should always be followed.

1. Balance pans before starting weighing.

2. Drugs should not be placed directly on scale pans. These should first be covered with pieces of paper. The opposite pan should be balanced by a piece of paper of equal weight. Unless the pans are equally balanced in this manner, serious mistakes may occur in weighing small amounts. The object of the paper on the pans is two fold. It keeps the pan clean and insures freedom from contamination with some previously weighed drug.

3. Balance accurately with material to be weighed. When a pointer is provided on the balance, it should swing an equal distance each side of the center or zero.

4. Always throw balance off center when through weighing. This stops the movements of the balance and consequently stops its wear.

5. In weighing liquids, tare (weigh) or balance the container first.

MEASURING

This is done in graduated vessels (graduates), graduated or measuring flasks and pipettes. The wider the vessel at the place of reading the greater is the liability to error. On this account greater accuracy can be obtained if the vessel is as narrow as possible where the reading is taken. The minim graduate is not accurate for measuring small amounts, as a considerable amount of the measured liquid is retained in the vessel by capillarity. A minim pipette is to be preferred for this purpose and also for the fact that there is less error in pouring more or less than the required amount into the graduate.

The cylindrical graduate has the advantage that equal accuracy can be obtained throughout while the conical shaped graduate has the advantage of greater accuracy for small amounts. A few rules for measuring should always be followed.

1. Hold the graduate so that the top of the liquid is a horizontal plane perpendicular to the long axis of the graduate and have the top of the liquid on a level with the eye.

2. On account of capillarity, the surface is always cupped, forming a meniscus. The reading should always be taken at the *lowest level* of the meniscus.

CHAPTER III

PHARMACEUTIC METHODS

THERE are several processes in the manufacture of pharmaceutic preparations, and these vary with the nature of the crude drug and the character of the desired product. These processes are:

Desiccation or Drying. This is usually the first step in the preparation of crude drugs. It has three advantages: it reduces bulk, assists preservation, and facilitates comminution. Drying was formerly done by storing in a dry, airy loft, but now most of it is done in special ovens. The degree of heat must not be high enough to destroy any of the desired or unstable ingredients. The next step is that of comminution.

Comminution. This is the reduction of the drug to smaller fragments. This process is now mainly done by machinery, quite similar to that used in grist or flouring mills. On a small scale the drug mill, which is similar in action to the coffee mill, may be used. The grinding has to be repeated several times in case of some drugs to get the powder fine enough. The mortar and pestle are used for friable substances. These are made of glass, wedgewood, porcelain and iron.

Trituration. Trituration is employed where a finer powder is desired than can be obtained with a mill. It consists of rubbing with a rotary motion, *not pounding,* the substance in a mortar with a pestle. Some substances will not powder alone but will if mixed with another substance (pulverization by intervention),— sugar of milk. Sometimes the substance requires moistening, as camphor with alcohol.

Certain drugs percolate better if used in a certain degree of fineness. They are, therefore, sifted and classified accordingly. If a very fine powder is desired of an insoluble substance, it may be mixed into a thick paste with water or alcohol and rubbed between two polished slabs (*Levigation*) or placed on a marble slab, moistened with alcohol or water and rubbed with a muller. In rubbing, a circular or figure eight motion should be used.

Separation. This is usually the next step in the preparation of drugs. Its purpose is to separate the desired ingredients from the inert or undesired. It may be accomplished in three ways. If the desired ingredients are volatile, they may be driven off by heat, i.e., by distillation or sublimation. If the substances are not volatile, the separation is usually done by exposing the crude drugs

to the action of some solvent in which the desired ingredients are soluble and the undesirable, so far as possible, insoluble. The third method is by mechanical means as in the case of fixed oils where the separation is done by pressure.

Separation by Heat. This method can be used whenever the substances to be separated have different boiling points, and are not destroyed by the necessary degree of heat. This process differs as to whether the fixed or volatile portion is desired and if the latter, according as to whether it is a solid or liquid. The different processes of using heat are: distillation, sublimation, carbonization, ignition, desiccation and torrefaction.

Distillation. This is the process of converting a liquid into a gas and condensing the gas back again into a liquid. The apparatus necessary is some receptacle for heating the liquid, conducting off and condensing the gas. The ordinary worm still is a good example. Its purpose is to separate volatile from non-volatile agents and for purifying volatile substances. It may be divided into fractional, which means a separation of a mixture of liquids, and destructive, where the substances are heated so strongly that they decompose and the volatile products which arise from the decomposition are saved. (Organic bodies as tar.)

Sublimation. This is a process exactly similar to distillation with the exception that solids are used instead of liquids. Usually the air is sufficient to cool and condense the vapors. (Benzoic acid, camphor, iodine.)

Desiccation. The object of desiccation is to drive off some undesired volatile substance from a solid, the fixed residue being the portion desired. If the heat is not sufficient to change the chemical composition, the process is termed desiccation. It simply means drying.

Carbonization. This is the process of heating organic substances under the exclusion of air. Its object is to change the chemical composition without oxidation. (Charcoal.)

Ignition. This is the process of strongly heating a substance, usually in a crucible, with full access to air, so as to complete oxidation. Nothing but ashes is left.

Torrefaction. This means roasting. The object is to employ sufficient heat to alter some of the constituents without affecting others. (Coffee, peanuts.)

Evaporation. This consists in vaporizing a solvent from a solution. The object is concentration of the desired dissolved substance.

Solution. This may be defined as the process of incorporating a solid into a liquid state of molecular subdivision, the result being a clear homogeneous fluid. In this case the molecules of the solid are diffused throughout the liquid, and are so widely sepa-

rated that no solid particles are in any way discernible. In other words, the solid is liquefied, and its molecules intermingle with those of the liquid (solvent). Solutions may be classified as simple, chemical, unsaturated, saturated, and supersaturated. A *simple* solution is one occurring as described above. No chemical change is made. A *chemical solution* where chemical action takes place. *Unsaturated* where the solvent contains less of the substance than it will dissolve. *Saturated* when it contains all that it will dissolve, and *supersaturated* when some means is employed to make the liquid dissolve more of the substance than the usual amount of the solid. Example, heat in most cases, or hydrochloric acid with corrosive sublimate.

The process of solution is applied to most organic drugs for the purpose of separating the active ingredients from the insoluble inert. The object is to dissolve the greatest amount of solid with the least possible liquid (menstruum). It accomplishes two purposes. 1. It gives a strong extract and (2) wastes no menstruum. Solution may be accomplished in various ways. All are combinations of two extremes, maceration and percolation, usually in the United States of both.

Maceration. This is simpler than percolation. It consists in simply leaving the drug in contact with the menstruum under suitable conditions, for a certain, or sufficient length of time. If maceration alone is used, a definite amount of the drug is placed in a container with a definite amount or portion of the menstruum and left a certain time, in many cases two weeks. The liquid is then strained off, the residue (marc) expressed and the mixed extract filtered.

The process is influenced by (1) degree of comminution. The finer the drug the less time is required. (2) The higher the temperature the quicker the solution. Different terms are given to the process according to the degree of temperature employed. *Maceration* is at room temperature, *Digestion* at 30°–40° C., *Decoction,* at boiling temperature. The application of heat is objectionable in certain cases because it injures some of the desired constituents or on account of the evaporation of either the constituent or solvent. (3) Time. Usually the longer the better. (4) Menstruum. This must in each case be adapted to the particular drug.

Percolation. Percolation or displacement is the process whereby a powder contained in a suitable vessel is deprived of its soluble constituents by the descent of a solvent through it. (Remington.)

The solvent, which is poured on the top of the powder, in passing downward exercises its solvent power on the successive layers of the powder until saturated, and is impelled downward by the combined force of its own gravity and that of the column of liquid above it, minus the capillary force with which the powder tends

to retain it. A *percolator* is a vessel with a porous diaphragm below, into which the drug, in the form of a powder, is introduced and its soluble portions extracted by the descent of the solvent through it. The *menstruum* or solvent is the liquid poured on top of the powder. The liquid coming from the percolator, impregnated with the soluble constituents of the drug, is the *percolate.*

The first portion of the percolate is always more dense, more highly colored and contains the largest proportion of the soluble principles, because the first proportion of the menstruum, in its descent through the powder, has the first opportunity to come in contact with the largest proportion of the soluble principles which are to be found in the finer dust scattered through the powder, and in the thoroughly disintegrated particles, which offer but slight resistance to the passage of the menstruum. When successfully conducted, the first portion of the percolate will be nearly saturated with the soluble constituents of the substance treated; if the quantity of the menstruum be sufficient for its exhaustion, the last portion of the percolate will be destitute of color, odor and taste, other than that possessed by the menstruum itself.

The general rule in percolation is to moisten the powder. The reason for this is that most drugs are vegetable substances which in their natural state were moist. The process of desiccation has hardened and dried the tissues, so that they do not absorb moisture quickly, and when compressed, as they are when packed in a percolator, the resistance is still greater. If a dry powder is tightly packed in a glass percolator and water poured upon it, the water will penetrate the powder but a short distance. Its further passage is prevented by the particles which are immediately in contact with the water, which have become swollen to such a degree that they press tightly against the sides of the percolator, and thus entirely overcome the gravitating force and penetrating power of the water. If, on the other hand, the powder is moistened with sufficient water to satisfy its tendency to swell, *before it is packed in the percolator,* the addition of water is followed by its slow colation through the mass without stoppage. A moist powder, like a moist sponge, greedily absorbs moisture, but a dry powder, like a dry sponge, repels attempts to moisten it.

Care should be used in preparing and packing a percolator, because upon this process largely depends the success of the operation. The powder should be packed firmly or moderately as directed. If packed too firmly the menstruum will not pass through readily, if not packed firmly enough the menstruum will pass through too quickly and the full strength of the drug will not be obtained; if packed unevenly, the menstruum will pass readily through one side of the mass and not come in contact with the other at all. The menstruum should descend uniformly and slowly through the drug.

Expression. This is the process of separating a liquid from a solid by pressure. It is especially used in pharmacy for the purpose of separating a liquid from a drug residue (marc) left after percolating or in separating fixed oils. The ordinary tincture or fruit press may be taken as an example.

Colation, or Straining. This is the process of separating solid, coarse particles from a liquid by pouring through a cloth or strainer.

Filtration. This is the process of separating fine or coarse, solid particles from a liquid by pouring it through a finely porous material, such as a filter paper.

Decantation. This means simply carefully pouring off most of the liquid portion, leaving the rest in the vessel. By repeating the process several times and adding more solvent each time, practically all the soluble material may be removed from the precipitate.

Clarification. This is the process of rendering turbid materials clear and transparent by removing the suspended solid bodies. Often when the solid particles cannot be removed by the filter, they may be removed by agitating them with some insoluble powder, or by adding egg albumen or shredded filter paper and by boiling or by centrifuge.

CHAPTER IV

DISPENSING

In dispensing medicines, every attention should be given to have the package neat and attractive. While any bottle or paper will serve in an emergency, we should so far as possible provide good, clean, unlabeled bottles, not old beer bottles, whiskey flasks, or patent medicine bottles, and dispense them wrapped in clean, new paper. Powders should always be placed in uniform paper and folded evenly, then wrapped in a neat package, or better still, dispensed in boxes of suitable size. These in turn should be neatly wrapped.

Powders-Chartæ. These are preparations of solid drugs in a fine state of division for external or internal use. Usually they are combinations of two or more drugs, and frequently one of the drugs only serves as a diluent or base. The drugs are usually mixed by triturating with a mortar and pestle although there are machines for this purpose. In mixing the materials, care should be taken to get the ingredients thoroughly and uniformly mixed. The mixing should be done by placing the smallest amount of the mixture in a mortar, triturating it with the next drug, then triturate after the addition of each drug. When individual powders are to be dispensed, the required number of papers, previously creased, should be placed upon the table and the mixture transferred to them with a spatula. After all the mixture has been transferred to the papers, the amount in each should be equalized, so far as possible by the eye. This method of division at best is only approximate and for exact work each powder should be weighed. Another very good method to divide the powder is to arrange it upon a smooth surface in the form of an elongated rectangle, and then divide this mass into equal portions with a spatula and transfer each portion to a paper.

To Fold Powders. This is learned very quickly and easily with a little practice. It consists of first laying the required number of papers upon a table or other smooth surface. Each paper should be provided with a fold of equal size at the top. After the powders have been placed upon the papers, the next step is to bring the bottom of the paper up to the crease already made. The flap of the crease is then bent down. Another fold is then made at the flap. Finally all that remains is to fold and crease the ends so that each powder is equal in length. They may be equalized in length by

breaking over the edge of a box or powder folder or the ends may be made to meet in each case. Papers may be folded upon either their long or short axis. Most people prefer to fold them upon their long axis although some prefer the other way for large powders. The chief advantages of the latter method are that a smaller paper is required and that the powder will be much flatter and consequently more easily wrapped. The following figures represent the various steps folding on both the long and short axis of the paper.

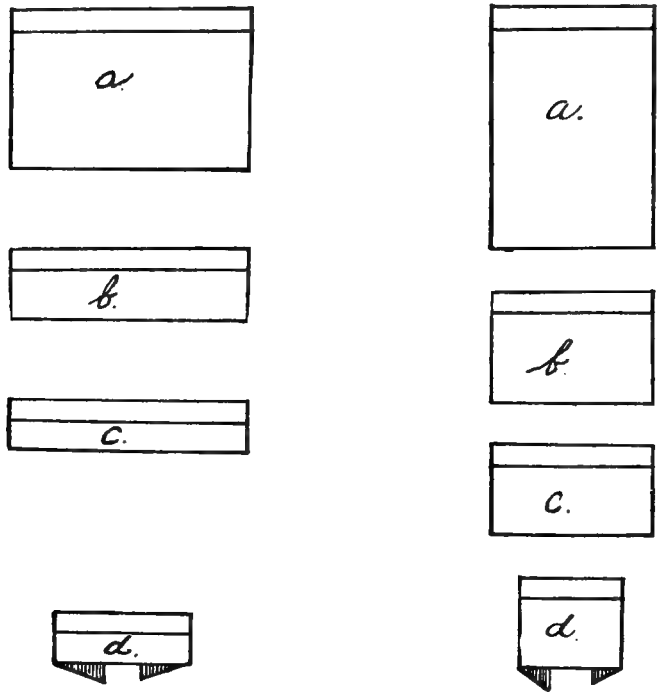

Fig. 1.— Folding powders.

After the powders have all been folded and smoothed down, they should be packed with the flaps alternating. This method of stacking saves a considerable amount of bulging and springing out of the powders under pressure.

Pills and Tablets should be dispensed in small envelopes, or if in boxes a small amount of absorbent cotton should be placed upon them in the box to prevent rattling. The boxes should be wrapped neatly.

To Wrap Round Boxes. Fig. 2. Place box on paper, bring two opposite ends together, fold and make a crease about one-half

inch in width. Then make a second fold on the first crease. This should bring the paper firmly around the edge of the box. Fold paper around the rest of the box and tie.

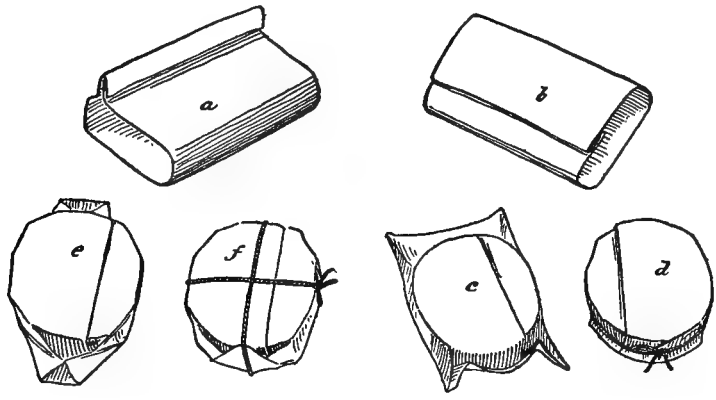

Fig. 2.— Wrapping round boxes.

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Oblong and Square Boxes (Fig. 3) are folded in much the same way. The first two steps are identical, except that the ends

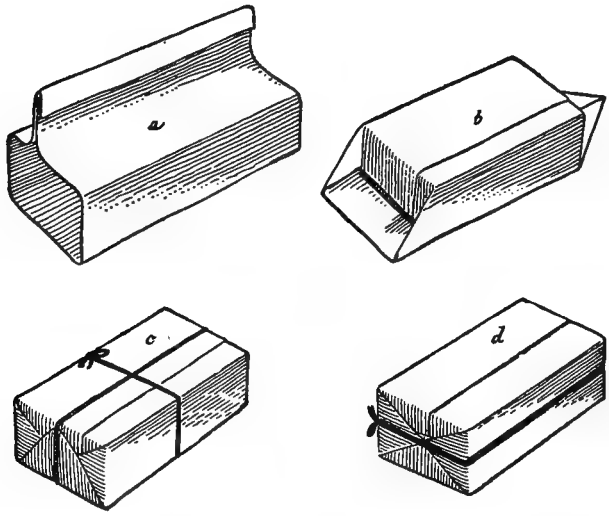

Fig. 3.— Wrapping oblong boxes.

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are to be folded in tightly against the ends of the box. A string is then passed two ways around the box and tied.

Packages. Fig. 4. In folding packages, first bring up two

opposite sides and crease evenly as in wrapping boxes. Fold this crease over on itself. Then temporarily close one end. Stand package on this end and carefully crease and fold the opposite end away from the flap. The package is then reversed, the other end

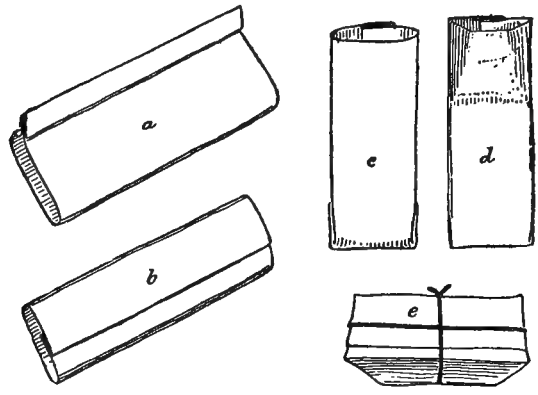

Fig. 4.— Folding packages.
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reopened and closed the same as the first one. Tie around both ways. This is similar to folding powders, and is used by some for that purpose, although a uniform size cannot be so easily obtained as where the papers are creased.

Bottles. Fig. 5. To wrap bottles. Make the first two folds as in case of wrapping a box. The open edge at the base is then

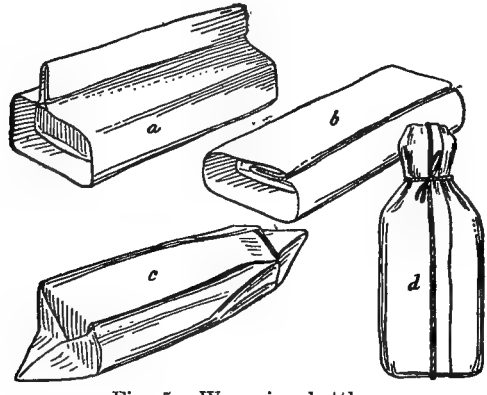

Fig. 5. Wrapping bottles.
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folded in flaps. The paper around the neck should be creased and folded in flaps. Tie around both ways.

Labelling. Write labels plainly and neatly.

CHAPTER V

PHARMACY PROPER

THE United States Pharmacopœia divides its preparations into certain groups which have been established by long usage. They may be tabulated as follows:

LIQUID PREPARATIONS

1. Solutions of volatile substances.

Aqueous	Aquæ (waters)
Alcoholic	Spiritus (spirits)

2. Solutions of non-volatile substances.

a. Simple solutions.

Aqueous	Liquores (solutions)
Aqueous (Viscid) (Mucilaginous)	Mucilagines, Mucilages
Aqueous Saccharine	Syrupi (syrups)
Mellifluous	Mellatæ (honeys)
Alcoholic	Tinctures except tincture of Iodine
Alcoholic Saccharine	Elixirs
Glycerinic	Glycerites
Ethereal	Collodia
Oleaginous	Oleates

b. Made by maceration or percolation.

Aqueous	Infusions and decoctions
Alcoholic	Tinctures and fluid extracts
Vinous	Wines
Ethereal	Oleoresins
Acetous	Vinegars

3. Liquids containing undissolved matter.

a. Internal use.

Aqueous with neither oil nor resin-Mixtures
Aqueous with either oil or resin-Emulsions

b. External use.

Oleaginous	Liniments

SOLID PREPARATIONS

1. Made by maceration or percolation.

A. Evaporation	Extracta (extracts)
B. Precipitation	Resinæ (resins)

2. Made without maceration or percolation.

a. For administration by mouth in undivided portions.

Pulverized	Chartæ or powders
Semisolid masses	Massæ or masses
Semisolid (sweet)	Confections

b. Individual doses.

Globular masses	Pilulæ or pills
Disk-like doses	Troches

c. By rectum — Suppositories

d. For external use.

Greasy masses used as

Plaster	Cerates
By inunction	Unguenta (ointments)
Moist masses	Cataplasma (poultices)
Sticky masses	Plasters
Spread on or absorbed by paper	Chartæ

UNOFFICIAL PREPARATIONS

Tabellæ — Tablets,
- Tablet — Triturates
- Tablets — Hypodermic
- Tablets — Dispensing
- Tablets — Compressed
- Tablets — Coated

Boli-Balls — (Sing. Bolus)
Haustus — Drench
Electuaria — Electuary

AQUAE

Waters are aqueous solutions of volatile substances. They differ from spirits, which are alcoholic solutions, and from liquores, which are aqueous solutions of non-volatile substances. There are twenty official waters and a general formula for aromatic waters in the Pharmacopœia of 1910.

They are divided into three classes according to their method of preparation: 1, Simple solution. 2, Filtration through an absorb-

ent powder. 3, Distillation. The following table mentions the official waters and designates the manner of preparation of each:

Simple solution or dilution

Aqua Amygdalæ Amaræ — Bitter almond
Aqua Aurantii Florum — Orange flowers
Aqua Chloroformi — Chloroform
Aqua Creosoti — Creosote
Aqua Rosæ — Rose

Filtration

Aqua Anisi — Anise
Aqua Camphoræ — Camphor
Aqua Cinnamomi — Cinnamon
Aqua Fœniculi — Fennel
Aqua Menthæ Piperitæ — Peppermint
Aqua Menthæ Viridis — Spearmint

Distillation

Aqua Aurantii Florum Fortior — Stronger orange flower water
Aqua Destillata — Distilled water
Aqua Destillata Sterilisata — Sterile distilled water
Aqua Hamamelidis — Witch-hazel
Aqua Rosæ Fortior — Stronger rose water

Gaseous solution

Aqua Ammoniæ — Ammonia water
Aqua Ammoniæ Fortior — Stronger ammonia water

The process of simple dilution or solution consists of adding the drug to a sufficient amount of water and agitating. In case of a gaseous solution, the gas must first be generated in a suitable apparatus, washed and passed into a cylinder containing water.

Filtration Through an Absorbent Powder. Excepting in the case of camphor water, this process is employed to obtain a saturated solution of volatile oil. Since these oils are but slightly soluble in water, they are triturated with an insoluble absorbent powder to separate them into finely divided form. After trituration with the powder, the water is gradually added. The result is that the finely divided drug is better brought into solution. Several powders have been recommended for use but all were more or less soluble and the Pharmacopœia specifies purified talcum. This is the method specified in the general formula for aromatic waters.

Distillation. In this case the product is put into a still with water and heat applied. The vapors arising from the still carry with them the volatile aromatic principles of the plant.

Waters are usually employed as pleasant vehicles for solution of various salts.

LIQUORES — LIQUORS — SOLUTIONS

Liquors are aqueous solutions of non-volatile substances. There are 25 official solutions in the Pharmacopœia. They may be divided into two classes according to the method of preparation. That is (1) *Simple solution* (Liquor Acidi Arsenosi) and (2) *solution through chemical change* (Liquor Ammonii Acetatis). The following table of official liquors indicates their method of preparation:

Simple Solution.

1. Liquor Acidi Arsenosi — Solution of Arsenous Acid.
2. Liquor Arseni et Hydrargyri Iodidi — Solution of Arsenous and Mercuric Iodides.
3. Liquor Formaldehydi — Solution of Formaldehyde.
4. Liquor Hypophysis — Solution of the Pituitary Body.
5. Liquor Iodi Compositus — Comp. Sol. of Iodine, Lugol's Solution.
6. Liquor Plumbi Subacetatis Dilutus.— Dil. Sol. of Lead Subacetate.
7. Liquor Potassii Hydroxidi — Solution of Potassium Hydroxide.
8. Liquor Sodii Arsenatis — Solution of Sodium Arsenate.
9. Liquor Sodii Chloridi Physiologicus — Physiological Salt Solution.
10. Liquor Sodii Glycerophosphatis — Sol. of Glycerophosphates.
11. Liquor Sodii Hydroxidi — Sol. of Sodium Hydroxide.

Chemical Action.

1. Liquor Ammonii Acetatis — Sol. of Ammonium Acetate.
2. Liquor Calcis — Lime water.
3. Liquor Cresolis Compositus — Compound Solution of Cresol.
4. Liquor Ferri Chloridi — Sol. of Iron Chloride.
5. Liquor Ferri et Ammonii Acetatis — Sol. of Iron and Ammon. Acet.
6. Liquor Ferri Subsulphatis — Sol. of Ferric Subsulphate.
7. Liquor Ferri Tersulphatis — Sol. of Ferric Sulphate.
8. Liquor Hydrogenii Dioxidi — Sol. of Peroxide of Hydrogen.
9. Liquor Magnesii Citratis — Sol. of Magnesium Citrate.
10. Liquor Plumbi Subacetatis — Sol. of Lead Subacetate.
11. Liquor Potassii Arsenitis — Sol. of Potassium Arsenite.
12. Liquor Potassii Citratis — Sol. of Potassium Citrate.
13. Liquor Sodii Chlorinatæ — Sol. of Chlorinated Soda.
14. Liquor Zinci Chloridi — Sol. of Zinc Chloride.

MUCILAGINES — MUCILAGES

Mucilages are aqueous adhesive liquors or jelly-like preparations containing a viscid substance (gum or starch) either in solution or suspension. All mucilages are prone to decomposition and on this account should be freshly prepared for internal use. The following are official:

Mucilago Acaciæ	Mucilage of Acacia.
Mucilago Tragacanthæ	Mucilage of Tragacanth.

SYRUPI — SYRUPS

Syrups are concentrated solutions of sugar in water usually medicated or flavored. A concentrated aqueous solution of sugar in water is called "*syrup*" or "*simple syrup.*" If the substance added to to the simple syrup is a pleasant fruit or aromatic, the product is termed a "*flavored syrup,*" while if the material added is of a medicinal nature, the product is a "*medicated syrup.*" There are 22 official syrups. Many of these are of but little importance so a list will not be given. According to the method used in manufacture, syrups may be classified as follows: 1. Solution with heat, e.g., Syrupus Calcis. 2. Agitation of sugar with medicated liquids or simple admixtures without heat, e.g., Syrupus Pruni Virginianæ. 3. Simple addition of medicated liquids to syrup, e.g., Syrupus Zingiberis. 4. Maceration or digestion, e.g., Syrupus Picis Liquidæ.

MELLITA — HONEYS

Honeys are thick liquid preparations containing medical agents blended with honey. In the early days of medicine they represented the most popular class of medical preparations, but have now been almost entirely replaced by the elixirs and syrups. The U. S. P. recognizes 3 official honeys.

Mel	Honey
Mel Depuratum	Clarified Honey
Mel Rosæ	Honey of Rose

EMULSA — EMULSIONS

Emulsions are aqueous preparations for internal use, in which resinous or fatty substances are suspended by means of mucilage or other viscid material. Acacia, Tragacanth and Yolk of Egg are often used for this purpose (Emulsifiers). In some instances, as in the case of emulsions of gum resins, the gum needed to form the emulsion is found present with the resin. The seeds of some plants

also contain an albuminous substance, which serves as an emulsifier for the oil also present in the seed, rendering the addition of gums unnecessary. The emulsions are all quite unstable and *accordingly should be freshly prepared for use.*

In making emulsions of fixed oils, in which case Emulsion of Cod Liver Oil serves as the best example, either of two processes may be employed: the English and the Continental. The latter is usually the more satisfactory. With this method a nucleus or primary emulsion is prepared first with certain proportions of the ingredients, and this can be further diluted with water or flavor without fear of splitting (Separation). The proportion by weight is: oil 4, water 2, and gum 1, or in other words, use twice as much oil as water, and twice as much water as gum. The nucleus is then diluted with water or flavor to the desired amount.

The following are official:

Emulsum Amygdalæ
Emulsum Asafœtidæ
Emulsum Olei Morrhuæ
Emulsum Olei Terebinthinæ

MISTURAE — MIXTURES

Mixtures are aqueous preparations for internal use containing in suspension insoluble, non-fatty substances. They are not permanent as a rule and should be freshly prepared. They should be dispensed with a shake label. Two are official, Mistura Cretæ and Mistura Glycyrrhizæ Composita.

MAGMAE

Magmæ are aqueous preparations containing thick, tenacious precipitates. Two are official: Magma Bismuthi and Magma Magnesiæ.

SPIRITUS — SPIRITS

Spirits are alcoholic solutions of volatile substances. As in case of waters, the volatile substances may be solid or liquid. Spirits containing some aromatic flavoring principles are frequently called "essences." They may be prepared in the following ways: 1. Dilution or solution. 2. Solution by maceration. 3. Solution by chemical action. Fifteen are official.

The following table of fifteen official spirits indicates the method by which prepared:

Simple Solution

Spiritus Ammoniæ Aromaticus	Aromatic Spirits of Ammonia
Spiritus Amygdali Amaræ	Spirit of Bitter Almond

Spiritus Anisi	Spirit of Anise
Spiritus Ætheris	Spirit of Ether
Spiritus Aurantii Compositus	Compound Spirit of Orange
Spiritus Camphoræ	Spirit of Camphor
Spiritus Chloroformi	Spirit of Chloroform
Spiritus Cinnamomi	Spirit of Cinnamon
Spiritus Glycerylis Nitratis	Spirit of Nitroglycerin
Spiritus Juniperi	Spirit of Juniper
Spiritus Juniperi Compositus	Compound Spirits of Juniper
Spiritus Lavandulæ	Spirit of Lavender

Solution by Maceration

Spiritus Menthæ Piperitæ	Spirit of Peppermint
Spiritus Menthæ Virdis	Spirit of Spearmint

Chemical Action

Spiritus Ætheris Nitrosi	Sweet Spirits of Niter Spirit of Nitrous Ether

ELIXIRIA — ELIXIRS

Elixirs are hydro-alcoholic solutions of an aromatic substance and sugar. They contain from 20 to 25 per cent. of alcohol. The following are official:

Elixir Aromaticum	Aromatic Elixir
Elixir Glycyrrhizæ	Elixir Glycyrrhiza (Licorice)

GLYCERITA — GLYCERITES

These are solutions or mixtures of drugs in glycerin. Most of them are solutions, but one, Glyceritum Amyli, is a semi-solid mass. They are nice preparations, and are usually employed externally. The following five are official:

Glyceritum Acidi Tannici	Glycerite of Tannic Acid
Glyceritum Amyli	Glycerite of Starch
Glyceritum Boroglycerini	Glycerite of Boroglycerin
Glyceritum Hydrastis	Glycerite of Hydrastis
Glyceritum Phenolis	Glycerite of Phenol

COLLODIA — COLLODIONS

These are preparations for external use. Simple collodion is a solution of Pyroxylin in Ether and Alcohol. The others have simple collodion as their base. When applied, the solvent evaporates very rapidly, leaving a film of Gun Cotton which is a good protective. Three are official:

Collodium	Collodion
Collodium Cantharidatum	Cantharidal Collodion
Collodium Flexile	Flexible Collodion

OLEATA — OLEATES

These were formerly defined as solutions of oxides or alkaloids in oleic acid but in the revision of the Pharmacopœia of 1910 but one is official, " Oleatum Hydrargyri "— so that oleate would be defined as a solution of an oxide in oleic acid. Oleates are applied by inunction and depend upon absorption from the skin for their physiological action. As stated above they are prepared by dissolving an oxide or an alkaloid in oleic acid. An excess of heat should be avoided in making metallic oleates, as the acid easily reduces the metals, especially when heated.

INFUSA — INFUSIONS

These are preparations of vegetable drugs made by maceration or percolation. In the one official infusion, Infusum Digitalis, and the general formula for making infusions, the water is poured on while boiling hot. Cold water should be used for those drugs whose active principle would be driven off or its formation prevented by boiling water.

DECOCTA — DECOCTIONS

Decoctions are liquids made by boiling the drug in closed vessels for fifteen minutes. They are then allowed to cool, strained and water added to make up the required amount. There are no official decoctions but the Pharmacopœia includes a general formula for their preparation. Decoctions and infusions do not keep well and should be freshly prepared for use.

TINCTURÆ — TINCTURES

Tinctures are alcoholic solutions of non-volatile substances obtained by the extraction of drugs. *Tincture of iodine* is an exception to the rule of non-volatile substances, while *both tincture of iodine and tincture of the chloride of iron* are made by solution. They differ from spirits in that, with the exception of tincture of iodine, the substances from which they are prepared are non-volatile. They differ from fluidextracts in respect to strength. They are weaker than fluidextracts and not uniform in strength, except that the potent tinctures are ten per cent. strength of the drug. Tinctures may be prepared by maceration, percolation, and solution or dilution.

The Pharmacopœia states that unless otherwise directed in the text, tinctures shall be made by one of two processes — Type P, Percolation, and Type M, Maceration.

TYPE PROCESSES FOR TINCTURES

Type Process P — Percolation. Moisten the powdered drug or mixed drugs as designated in the formula with a sufficient quantity of the prescribed menstruum to render it evenly and distinctly damp, transfer it to a percolator, and, without pressing the powder, allow it to stand well covered for six hours, then pack it firmly, unless otherwise directed, and pour on enough of the menstruum to saturate the powder and leave a stratum above it. When the liquid begins to drop from the percolator, close the lower orifice, and, having closely covered the percolator, macerate for twenty-four hours. Then allow the percolation to proceed slowly, gradually adding sufficient of the menstruum to make one thousand mils of the finished tincture.

Type Process M — Maceration. Macerate the drug or mixed drugs designated in the formula in a stoppered container, in a moderately warm place, with seven hundred and fifty mils of the prescribed solvent (unless a different amount is specified in the formula). Continue the maceration with frequent agitation during three days or until the drug is practically extracted, transfer the mixture to a filter and, when the liquid has drained off completely, gradually wash the residue on the filter with enough of the solvent to make one thousand mils of finished tincture.

There are 54 official tinctures. The following table gives a list of official tinctures together with method of preparation and menstruum employed:

By Solution or Dilution

PREPARATION	SOLVENT
Tinctura Ferri Chloridi	Alcohol 650 mils Sol. of Ferric Chloride 350 mils
Tinctura Iodi	Alcohol 950, Water 50

Maceration Type M

MENSTRUUM	PREPARATION
Alcohol, U. S. P.	Tinctura Asafœtidæ Tinctura Aurantii Dulcis Tinctura Benzoini Tinctura Benzoini Composita Tinctura Guaiaci Tinctura Myrrhæ Tinctura Limonis Corticis Tinctura Tolutana Tinctura Lavandulæ Composita
Alcohol 750 mils, Water 250 mils	Tinctura Scillæ

MENSTRUUM	PREPARATION
Diluted Alcohol	Tinctura Aloes
	Tinctura Gambir Composita
	Tinctura Moschi
Boiling water 500 Alcohol 500 mils	Tinctura Kino
Glycerin 50 mils Diluted Alcohol 950 mils	Tinctura Cardamomi Composita
Glycerin 40 mils, Diluted Alcohol 950 mils	Tinctura Opii Camphorata
Aromatic Spirits of Ammonia	Tinctura Guaiaci Ammoniata

Of the above, squill is made by maceration and expression.

Made by Percolation Type P

MENSTRUUM	PREPARATION
Alcohol, U. S. P.	Tinctura Cannabis
	Tinctura Cantharidis
	Tinctura Physostigmatis
	Tinctura Pyrethri
	Tinctura Strophanthi
	Tinctura Veratri Viridis
	Tinctura Zingiberis
Alcohol 950 mils, Water 50 mils	Tinctura Capsici
Alcohol 750 mils, Water 250 mils	Tinctura Nucis Vomicæ
	Tinctura Valerianæ
	Tinctura Digitalis
Alcohol 700 mils, Water 300 mils	Tinctura Aconiti
Alcohol 650 mils, Water 350 mils	Tinctura Gelsemii
Alcohol 666 mils, Water 333 mils	Tinctura Hydrastis
Alcohol 600 mils, Water 400 mils	Tinctura Aurantii Amari
	Tinctura Calumbæ
	Tinctura Colchici Seminis
Glycerin 100 mils, Alcohol 500 mils, Water 400 mils	Tinctura Gentianæ Composita
Diluted Alcohol	Tinctura Arnicæ
	Tinctura Belladonnæ Foliorum
	Tinctura Cardamomi
	Tinctura Hyoscyami
	Tinctura Lobeliæ
	Tinctura Opii
	Tinctura Stramonii
Alcohol 333 mils, Water 666 mils	Tinctura Quassiæ
Alcohol 200 mils, Water 800 mils	Tinctura Opii Deodorata
Glycerin 75 mils, Alcohol 675 mils, Water 250 mils	Tinctura Cinchonæ
	Tinctura Cinchonæ Composita
	Tinctura Cinnamomi

MENSTRUUM	PREPARATION
Glycerin 250 mils, Alcohol 500 mils, Water 250 mils	Tinctura Lactucarii
Glycerine 100 mils, Alcohol 500 mils, Water 400 mils	Tinctura Rhei Tinctura Rhei Aromatica
Hydrochloric acid 10 mils, Alcohol 600 mils, Water 400 mils	Tinctura Sanguinariæ
Aromatic Spirits of Ammonia	Tinctura Valerianæ Ammoniata

FLUIDEXTRACTA — FLUIDEXTRACTS

Fluidextracts are concentrated liquid preparations of vegetable drugs, containing alcohol either as a solvent or preservative and bearing a uniform relation to the drug used so that one mil of the fluidextract closely represents the activity of one gram of the air dried powdered drug of standard quality. They possess the following advantages over tinctures: 1. They have a definite strength, representing 100 per cent. of the activity of the crude drug, consequently the dose is the same as for the crude drug and need not be especially remembered. 2. They are so concentrated that less is required for action, and 3. They keep better than tinctures and some improve with age.

With few exceptions, the fluidextracts of the Pharmacopœia may be classified according to the menstrua used in the extraction of the drugs and the process of manufacture employed, but there are several drugs which require special manipulation to make satisfactory preparations and for them definite formulas have been devised and are printed in full in the text. The formulas for the other fluidextracts correspond to one of the following types:

Type Process A. In this class are included those fluidextracts that are made with a menstruum of alcohol or a mixture of alcohol and water by the usual process of percolation.

Type Process B. In this group are included those fluidextracts in which glycerin or an acid is used in the extraction and two menstrua are successively employed. The first menstruum contains the acid or glycerin in definite proportion to the amount of drug while the second consists of a mixture of alcohol and water intended for completing the exhaustion of the drug.

Type Process C. This is the process of fractional or divided percolation (repercolation). It is especially recommended for drugs containing volatile ingredients, or constituents injured by heat, but may be used as an alternative process in the formulas in which Type Process A is directed.

Type Process D. In this class are included those fluidextracts in which extraction is effected by infusion and percolation with boiling water, alcohol being added to the concentrated liquid as a preservative.

In the preparation of fluidextracts by either process A, B, or C the rate of percolation must be perfectly controlled and, for the quantities directed in the formulas of the Pharmacopœia (1000.0 Gms.) the rate of flow should not exceed ten drops per minute, until the reserve percolate is collected and twenty drops per minute thereafter.

DIRECTIONS FOR THE DIFFERENT TYPE PROCESSES

Type Process A. Moisten required amount of the powdered drug with a sufficient amount of the prescribed menstruum to render it evenly and distinctly damp and to maintain it so, after macerating for six hours in a tightly covered container. Then pack it in a cylindrical percolator and add enough of the menstruum to saturate the powder and leave a stratum above it. When the liquid begins to drop from the percolator, close the lower orifice, and, having closely covered the percolator, macerate for forty-eight hours. Then allow the percolation to proceed slowly, gradually adding more menstruum until the drug is exhausted. Reserve the first eight hundred and fifty mils of the percolate (unless otherwise specified in the formula); recover the alcohol from the remainder and concentrate the residue to a soft extract at a temperature not exceeding 60° C.; dissolve this in the reserved portion, mix thoroughly, and finally add a sufficient quantity of the menstruum to obtain one thousand mils or the volume determined by calculation or directions.

Type Process B. Moisten one thousand grams of the powdered drug directed with a sufficient quantity of the prescribed Menstruum I to render it evenly and distinctly damp and to maintain it so after maceration for six hours in a tightly covered container. Then pack it in a cylindrical percolator, add the remainder of Menstruum I, and when this has just disappeared from the surface, gradually add Menstruum II, constantly maintaining a stratum of liquid above the drug.

When the liquid begins to drop from the percolator, close the lower orifice, and, having closely covered the percolator, macerate for forty-eight hours, and then allow the percolation to proceed slowly, gradually adding Menstruum II until the drug is exhausted. Reserve the first eight hundred and fifty mils of the percolate (unless otherwise directed in the formula); recover the alcohol from the remainder and concentrate the residue to a soft extract at a temperature not exceeding 60° C.; dissolve this in the reserved portion, mix thoroughly, and finally add a sufficient quantity of Menstruum II to obtain one thousand mils, or the volume determined by calculation from assay.

Type Process C. Divide one thousand grams of the powdered drug directed into three portions of five hundred grams, three hun-

dred grams, and two hundred grams, respectively. Moisten the first portion of the drug (500 Gms.) with a sufficient quantity of the prescribed menstruum to render it evenly and distinctly damp and to maintain it so after maceration for six hours in a tightly-covered container. Then pack it in a cylindrical percolator and add enough menstruum to saturate the powder and leave a stratum above it. When the liquid begins to drop from the percolator, close the lower orifice, and, having closely covered the percolator, macerate for forty-eight hours and then allow the percolation to proceed slowly, gradually adding more menstruum. Reserve the first two hundred mils of the percolate and continue the process until the additional percolate measures fifteen hundred mils, the latter being collected in successive portions of three hundred mils each.

Moisten the second portion of the powdered drug (300 Gms.) with a sufficient quantity of the percolate collected in the preceding operation immediately after the reserved portion to render it evenly and distinctly damp and to maintain it so after macerating for six hours in a tightly-covered container. Then pack it in a cylindrical percolator and macerate and percolate as directed for the first part of the drug, using as menstruum the several portions of percolate from the preceding operation in the order in which they have been collected, and if this be insufficient, follow with some of the original menstruum. Reserve the first three hundred mils of percolate and continue the process until the additional percolate measures eight hundred mils, collecting the weaker percolate in successive portions of two hundred mils each.

Moisten the third portion of the powdered drug (200 Gms.) with a sufficient quantity of the percolate collected in the preceding operation immediately after the reserve portion to render it evenly and distinctly damp and to maintain it so after macerating for six hours in a tightly-covered container. Then pack it in a cylindrical percolator and macerate and percolate as before, using as menstruum the several portions of the percolate from the preceding operation in the order in which they have been collected, and, if this be insufficient, follow with more of the original menstruum. Collect five hundred mils of percolate and mix this with the two portions previously reserved so as to make one thousand mils of finished fluidextract.

When Type Process C is directed for fluidextracts which are adjusted by assay to a definite alkaloidal standard, collect only four hundred and twenty mils of percolate from the third portion of the drug instead of the five hundred mils as directed above. Mix this percolate with the two portions previously reserved, assay a portion of the mixture and then adjust its volume, by the addition of the menstruum directed, so that each one hundred mils of finished fluidextract will contain the prescribed amount of alkaloid.

Type Process D. To one thousand grams of the ground drug

add five thousand mils of boiling water, mix thoroughly and allow it to macerate in a covered container for two hours in a warm place. Then transfer the moist drug to a tinned or enameled metallic percolator and allow percolation to proceed, gradually adding boiling water until the drug is exhausted. Evaporate the percolate on a water bath or steam bath to the volume specified, and when cold add the alcohol directed and mix thoroughly.

VINI — WINES

Wines are liquid preparations containing the soluble principles of medicinal substances, dissolved in wine. They may be prepared by solution or maceration, and differ from tinctures only in the solvent employed, i.e., wine instead of alcohol in various strengths. Ten were official in the Pharmacopœia of 1900 but they were all dropped from the last revision.

OLEORESINAE — OLEORESINS

The pharmaceutic oleoresins are liquid preparations consisting principally of volatile oils and resins, obtained by the extraction from vegetable drugs by percolation with ether or alcohol and subsequent distillation or evaporation of the solvent from the dissolved portions. There are two groups of oleoresins, the natural and the pharmaceutic. The former are mixtures of volatile oils and resins which exude from plants. (Turpentine, Copaiba). They are quite different from the pharmaceutic class described above. Oleoresins are the *most concentrated* of all liquid preparations of drugs. Their strength varies, however, but usually runs from 5 to 10 times the strength of the crude drug.

Preparation. With slight differences they are prepared in a manner similar to fluidextracts. They are placed in a percolator without moistening, the menstruum is usually different, and a special percolator for volatile liquids should be used for the best results. The following 6 are official:

Solvent Ether	Oleoresina Aspidii	Oleoresin of Aspidium
	Oleoresina Capsici	Oleoresin of Capsicum
	Oleoresina Petroselini	Oleoresin of Parsley Fruit
	Oleoresina Piperis	Oleoresin of Pepper
	Oleoresina Zingiberis	Oleoresin of Ginger
Solvent Alcohol	Oleoresina Cubebæ	Oleoresin of Cubebs

ACETA — VINEGARS

These are liquid preparations of the active principles of drugs, prepared by extraction with *Diluted Acetic Acid.* They resemble

tinctures except for the solvent used. Acetic Acid is a good solvent for many of the active ingredients of plants and serves as a preservative. It also produces soluble salts with the alkaloidal principles of plants. But one is official:

Acetum Scillæ, Vinegar of Squill

This is prepared with Diluted Acetic Acid (6 per cent. by weight of absolute Acetic Acid), and is made by maceration. It represents 10 per cent. of the active drug.

EXTRACTA — EXTRACTS

Extracts are solid or semi-solid preparations of the active constituents of drugs prepared by percolation of the crude drug with the proper menstruum and evaporation of the percolate. The menstruum may be water, alcohol, or various proportions of water and alcohol, or ammonia, and extracts made from such a percolate are termed respectively, *aqueous, alcoholic, hydro-alcoholic,* or *ammoniated* extracts. Besides the above the juices of fresh plants, extracted by contusion and expression, are often evaporated and known as "inspissated juices." These are popular in England but none are official in this country. There are 25 official extracts. As a rule the extracts are not so satisfactory as the fluidextracts or tinctures because they vary in strength, the dose is exceedingly small and the soft ones are difficult to manipulate.

Table of Extracts

Extractum Aconiti	Powdered
Extractum Belladonnæ Foliorum	Powdered and Pilular
Extractum Cannabis	Pilular
Extractum Cascaræ	Powdered
Extractum Cimicifugæ	Powdered
Extractum Colchici Cormi	Powdered
Extractum Colocynthidis	Powdered
Extractum Colocynthidis Compositum	Powdered
Extractum Ergotæ	Pilular
Extractum Fellis Bovis	Powdered
Extractum Gelsemii	Powdered
Extractum Gentianæ	Pilular
Extractum Glycyrrhizæ	Brittle
Extractum Glycyrrhizæ Purum	Pilular
Extractum Hydrastis	Powdered
Extractum Hyoscyami	Pilular
Extractum Malti	Thin Liquid
Extractum Nucis Vomicæ	Powdered
Extractum Opii	Powdered

Extractum Physostigmatis	Powdered
Extractum Rhei	Powdered
Extractum Stramonii	Powdered and Pilular
Extractum Sumbul	Pilular
Extractum Taraxaci	Pilular
Extractum Viburni Prunifolii	Powdered

RESINAE — RESINS

Resins are chemically solid plant substances or exudations usually acid in character, insoluble in water but soluble in water and an alkali. However, the pharmaceutic class — resins — are those plant substances insoluble in water, soluble in alcohol, obtained either as a residue left after the distillation of an oleoresin or by precipitating them by pouring a concentrated alcoholic extract of the drug into water or acidulated water. All official resins except rosin are obtained in this way. Four are official:

Resina	Rosin
Resina Jalapæ	Resin of Jalap
Resina Podophylli	Resin of Podopyllum
Resina Scammoniæ	Resin of Scammony

LINIMENTA — LINIMENTS

Liniments are liquid preparations for external use to be applied by friction. They are usually solutions or mixtures of oily or alcoholic substances containing fatty oils. Some official liniments are solid or semisolid preparations. Eight liniments are official. Three have a fixed oil as a base, three alcohol, one turpentine, and one a fluidextract. The following table indicates the base in each:

Alcoholic —	
Basis Alcohol	Linimentum Saponis, Soap Liniment
Basis Alcohol	Linimentum Saponis, Mollis
Basis Soap Liniment	Linimentum Chloroformi
Basis Fluidextract	Linimentum Belladonnæ
Oleaginous —	
Basis Cotton Seed Oil	Linimentum Camphoræ
Basis Linseed Oil	Linimentum Calcis
Basis Sesame Oil	Linimentum Ammoniæ
Basis Turpentine Oil	Linimentum Terebinthinæ

PULVERES — POWDERS

These are preparations of, or combinations of, solid drugs in a fine state of division, for external or internal use. See p. 17. The pulverization is done to facilitate solution of the ingredients. Seven are official:

Pulvis Aromaticus	Aromatic powder
Pulvis Cretæ Compositus	Compound chalk powder
Pulvis Effervescens Compositus	Compound effervescing powder
Pulvis Glycyrrhizæ Compositus	Compound licorice powder
Pulvis Ipecacuanhæ et Opii	Dover's powder
Pulvis Jalapæ Compositus	Compound powder of jalap
Pulvis Rhei Compositus	Compound powder of rhubarb

TRITURATIONES — TRITURATIONS

These preparations were suggested by similar preparations used in homeopathy. The general formula for triturations as directed by the Pharmacopœia is

Substance	10.00 Gm.
Sugar of Milk	90.0 Gm.

Weigh the substance and the sugar of milk separately; then place the substance, previously reduced if necessary, to a moderately fine powder, in a mortar; add about an equal measure of sugar of milk, mix well by means of a spatula and triturate the powders thoroughly together. Then add fresh portions of sugar of milk from time to time, until the whole is added, and continue the trituration after each addition until the substance is intimately mixed with the sugar of milk and reduced to a fine powder.

MASSÆ — MASSES

These are combinations of medical substances, incorporated with enough liquid to make a consistency for pills. Two are official,

Massa Ferri Carbonatis	Vallet's Mass
Massa Hydrargyri	Blue Mass

CONFECTIONES — CONFECTIONS

Confections are soft, solid saccharine preparations in which the medicinal agent is combined with saccharine substances, as jellies, pulp of fruit or honey. They are also called conserves or electuaries.

PILULÆ — PILLS

Pills are small globules, spherical or lenticular in shape, containing one dose of medicinal substance and intended to be swallowed whole. Since they are so easily made by machinery, but few are now made by hand. There are three steps in the manufacture of pills.

1. Making the mass,
2. Dividing the mass,
3. Rolling the pills.

After they are rolled, they may be coated with gelatin, sugar, chocolate, keratin, etc.

Seven are official:

Pilulæ Aloes	Aloes Pills
Pilulæ Asafœtidæ	Asafœtida Pills
Pilulæ Catharticæ Compositæ	Compound Cathartic Pills
Pilulæ Ferri Carbonatis	Blaud's Pills
Pilulæ Ferri Iodidi	Iodide of Iron Pills
Pilulæ Phosphori	Phosphorus Pills
Pilulæ Rhei Compositæ	Compound Rhubarb Pills

TROCHISCI — TROCHES

These are disc-like masses of medicinal substances, consisting chiefly of medical powders, sugar and mucilage, intended to be slowly dissolved in the mouth. Powerful or disagreeable drugs should not be given in this manner, and it is needless to say that they cannot be used in veterinary medicine. They may be manufactured by massing or compression. In the former case the medicine is combined with some mucilaginous substance with sufficient water to make a mass, and then worked in a mortar to a mass. This is rolled out and then cut with a lozenge cutter.

By Compression. The manufacture of troches by compression differs from that of tablets only by the size of the mold. Five are official:

Trochisci Acidi Tannici	Troches of Tannic Acid
Trochisci Ammonii Chloridi	Troches of Ammonium Chloride
Trochisci Cubebæ	Troches of Cubebs
Trochisci Potassii Chloratis	Troches of Potassium Chlorate
Trochisci Sodii Bicarbonatis	Troches of Sodium Bicarbonate

UNGUENTA — OINTMENTS

Ointments are semisolid preparations in which the medical substances are blended with fatty substances, lard, petrolatum, etc., and soft enough to be applied to the skin by inunction. They are always softer than cerates, which see. They may be prepared by incorporation or fusion. When made by the former method, the medical substance is rubbed with the solid fatty matter in a mortar or upon an ointment slab with a spatula. When made by fusion the fatty base is liquefied by gentle heat and the medicine incorporated while liquid or after solidification. Twenty are official.

Unguentum, a base for other ointments	Unguentum Aquæ Rosæ
Unguentum Acidi Borici	Unguentum Belladonnæ
Unguentum Acidi Tannici	Unguentum Chrysarobini (Chrysarobin)

Unguentum Diachylon
Unguentum Gallæ (Nutgalls)
Unguentum Hydrargyri
Unguentum Hydrargyri Ammoniati
Unguentum Hydrargyri Dilutum (Blue ointment)
Unguentum Hydrargyri Nitratis
Unguentum Hydrargyri Oxidi Flavi
Unguentum Iodi
Unguentum Iodoformi
Unguentum Phenolis
Unguentum Picis Liquidæ
Unguentum Stramonii
Unguentum Sulphuris
Unguentum Zinci Oxidi

CERATA — CERATES

These are preparations of medicinal substances with fats and waxes of such a consistency as to be soft enough to spread upon muslin or other material and not soft enough to liquefy when applied to the skin. They are called *Cerates* because they contain wax or *cera*. They may be prepared by fusion or incorporation but all the official ones are directed to be made by the former method. Three are official:

Ceratum	Cerate. Used only as a base
Ceratum Resinæ	Resin or Rosin Cerate
Ceratum Cantharidis	Cantharides Cerate

SUPPOSITORIA — SUPPOSITORIES

Suppositories are solid bodies of various shapes and weights, adapted for the introduction into various orifices of the body, and melting or softening at body temperature. The vehicles usually employed are oil of theobroma, glycerinated gelatin and sodium stearate. The ideal suppository consists of a medicine blended with some inert base which will not liquefy at ordinary temperatures but will melt at the body temperature. They may be prepared by three processes, rolling, molding and compression. The first method consists of making a mass, rolling it into a cylinder, cutting the cylinder and shaping with the hands. In case of those made by molds, the mass is liquefied and poured into thoroughly chilled molds. By compression the medical substance is mixed with finely grated oil of theobroma and compressed with a lever.

There is one official suppository — Suppositoria Glycerini, besides which the Pharmacopœia contains general formulas for those made with oil of theobroma and glycerinated gelatin.

CATAPLASMA — CATAPLASMS — POULTICES

These are wet masses of solid matter applied to the skin for the purpose of reducing inflammation, or in other cases to act as counter-irritants. The solid matter as the base is chosen with a view to its capacity for absorbing water. Thus the base of the one former offi-

cial cataplasma is clay, while mucilaginous drugs, such as flaxseed, are valuable for poultice bases.

If the poultice is intended to reduce inflammation, the proper base is one devoid of medical action, and the poultice wet with cold water or liquid acts similarly to a cold compress. If intended to act as a counterirritant, the poultice is either applied hot or is made of some drug which has rubifacient properties. (Mustard poultice.) Cataplasma Kaolini belongs to the class of mechanical non-medicinal poultices used for allaying inflammation. It was official in the Pharmacopœia of 1905.

EMPLASTRA — PLASTERS

Plasters are solid preparations containing medicinal substances intended to be applied to the skin, and of sufficient adhesiveness to adhere firmly. They differ from cerates in being free from fats and also from the fact that cerates, when spread on cloth and applied are not of sufficient adhesiveness to stick firmly to the skin. The bases of plasters consist of gum resins, lead plaster, resin plaster, burgundy pitch, isinglass, and India rubber. In former times the first named bases were often used, but the machine made plasters with a rubber base have largely replaced them.

The following are official:

Emplastrum Belladonnæ	Belladonna Plaster
Emplastrum Cantharidis	Cantharides Plaster
Emplastrum Capsici	Capsicum Plaster
Emplastrum Elasticum	Rubber Plaster
Emplastrum Plumbi	Lead Plaster
Emplastrum Resinæ	Resin or Rosin Plaster
Emplastrum Sinipis	Mustard Plaster

CHARTAE — PAPERS.

These are a class of preparations in which the medicine is spread upon paper or absorbed by it. There are no official papers. Charta-Sinipis, Mustard Paper, was official in U. S. P. of 1900 and Charta Potassii Nitratis in U. S. P. of 1890.

UNOFFICIAL PREPARATIONS

Many unofficial preparations are in so common use that it seems best to include a few of them. The most common are: Tabellæ — Tablets (tablet triturates, compressed tablets, hypodermic tablets); Boli — Bolus, Ball (capsules, haustus, electuary).

TABELLAE — TABLETS

Tablets are small disc-shaped bodies containing medicinal agents. With the exception of *Toxitabellæ Hydrargyri Chloridi*

Corrosivi they are unofficial but nevertheless largely employed. There are several varieties: tablet triturates, compressed tablets, coated tablets, hypodermic tablets and dispensing tablets.

Tablet triturates are prepared by triturating the medicament with finely powdered sugar of milk if powerful agents are used, or if the substance requires no dilution, triturating it to a very fine powder, moistening the powder with sufficient alcohol or other volatile substance to make a paste. The moistened powder is then pressed into molds consisting of a plate perforated with holes and then the tablets are pressed out by fitting this perforated plate over another plate upon which are situated pegs that accurately fit the perforations. The liquid is evaporated very quickly, after which the tablets retain their shape and are ready for use. They possess advantages over any other method of administering solids in human and small animal practice as they are more conveniently administered than powders and are more soluble than pills, compressed tablets or capsules. Well made triturates disintegrate almost immediately on being placed in water.

Hypodermic tablets are made by the same process. The selection of the diluent is an important question because rapid solubility is desired. Dried neutral sodium sulphate has been largely employed and frequently they contain in addition some substance which produces chemical change when added to water and causes a rapid disintegration of the mass.

Compressed tablets are made from dried, granulated materials by compression in a suitable machine. They are less soluble than tablet triturates. Compressed tablets of insoluble material should not be used.

Coated tablets are compressed tablets covered with sugar, chocolate, etc.

Dispensing tablets are those which contain a relatively large amount of the active drug like strychnine 1 gr. or ½ gr. They are used by pharmacists and those who dispense their own remedies in order to avoid the necessity of weighing small amounts of powerful drugs in filling prescriptions.

BOLUS BOLI — BALLS

A bolus may be defined as a large pill. The term literally means mass or lump. Its use is restricted to veterinary medicine. They are made very similarly to pills. The ingredients are finely powdered and thoroughly mixed, after which an excipient, such as soap, syrup, glycerin, or molasses, is added to make a mass of proper consistency. The mass is then divided into the proper number of doses and each portion is molded into the form of a cylinder with rounded ends. They may be wrapped in thin paper or placed in capsules.

Very few practitioners make their own balls on account of the cheapness at which they may be purchased.

℞	Aloes	ʒ viij	30.0 Gm.
	Calomel	gr. xxx	2.0 Gm.
	Ginger	ʒ j	4.0 Gm.
	Nux Vomica	gr. xxx	2.0 Gm.
	Glycerin		
	Simple syrup āā	ʒ j	4.0 mils

Heat the aloes, glycerin and syrup on a water bath at a temperature not to exceed 120° F., until the aloes is melted, add the ginger and nux vomica and mix thoroughly. Then add about 15 drops of alcohol. Mix and pour upon a plate covered with lycopodium. After the mass has cooled sufficiently mold into shape and wrap in thin paper.

or

℞	Aloes	ʒ viij
	Calomel	gr. xxx
	Ginger	ʒ j
	Nux Vomica	gr. xxx
	Glycerin	
	Simple syrup āā	q. s.

Mix the aloes, ginger, nux vomica and calomel and then add enough of equal parts of simple syrup and glycerin to make a mass. Mold into shape and wrap in thin paper.

CAPSULAE — CAPSULES

Capsules are ovoid or cylindrical shells of gelatin used for the administration of various forms of medicines, powders, masses or liquids. They are termed hard or soft according to the amount of glycerin contained in the mass from which they are made. Hard capsules consist of a shell and cap or cover. They are a fairly popular means of administering medicines in veterinary practice. They may be filled with powders by placing the powder upon a clean piece of paper and gently pressing the shell into the mixture when it will gradually fill. In order to get the exact amount in each capsule they should be weighed. This may be easily done by having the weight plus an empty capsule on one scale pan and throwing the filled capsule upon the other pan. If not sufficiently filled a little more pressure will bring the desired amount and if it is already over-filled a slight tapping upon the inverted capsule will throw out the excess. In case of very large capsules the powder may be poured directly into the capsule and cap. Liquids may also be poured into the shell of the larger capsules or dropped into the smaller ones by means of a pipette or burette. It is needless to say that liquids which dissolve gelatin must not be placed in capsules unless they are to be given at once.

HAUSTUS — DRENCH

A haustus or drench may be defined as an extemporary liquid preparation intended to be given immediately in one dose.

ELECTUARIUM — ELECTUARY

Electuaries are medicinal pastes to be smeared on the teeth of animals where they melt at body temperature and are absorbed or are free to act locally upon the tissues of the mouth and throat. Usually a specified quantity is dispensed as a sample dose or one of the common domestic measures may be used.

ASSAYING

On account of the different conditions under which plants grow, the different methods used in collecting, drying and preserving them and the effects of age upon their active ingredients, crude drugs vary greatly in strength. Because of this variability the use of the active principles has certain advantages; they are more rapidly absorbed, have a constant strength and many may be used subcutaneously. On the other hand, there are some cases in which it is impossible or too expensive to isolate the active principles in pure form, or there may be a preference for the mixtures or combinations in the same proportions in which they occur in nature, so that the pharmaceutic preparations and even the powdered crude drugs are very often employed, even when the active ingredients are available.

In order to make some of the more potent drugs uniform in strength, the United States Pharmacopœia standardizes them to contain a definite percentage of the active principles by *assaying.* The *process of assaying* is a process by which the strength of a preparation is determined.

There are three kinds of assay processes for drug standardization: chemic (volumetric), pharmaceutic (galvimetric) and physiologic. The physiologic process is devised for certain drugs whose active ingredients are not readily isolated.

SOLUBILITIES OF SALTS

A general idea of solubility of salts is essential for prescribing or dispensing them. The following tables according to Sollmann include only those salts in general use:

I. Arranged by Acids.

Group A. Salts mostly soluble.

1. *Acetates and Nitrates:* all soluble except bismuth subnitrate.

2. *Halogen* group = (iodids, bromides and chlorides): soluble except Ag; Hg (ous); Pb; Bi.
3. *Sulphates:* soluble except Pb, Ba, Sr; Ca sparingly soluble.
4. *Tartrates* and *Citrates* mostly soluble.

Group B. Salts mostly insoluble.

1. *Arsenates*
   Arsenites
   Carbonates
   Hydrates (Ca sparingly soluble)
   Oxides
   Oxalates
   Borates
   Phosphates

   } Insoluble except those of alkali metals.

II. Arranged by Base.

The salts considered in this table are: Acetates (Ac), Oxides (O), Halogens (H), Sulphates (SO_4), Phosphates (PO_4), Oxalates (O_x), Carbonates (CO_3), Sulphides (S), Nitrates (NO_3), Citrates (Ci); Hydrates agree with oxides. Those of the above salts which are *not mentioned* with the respective base are insoluble.

1. *Alkali Metals* (Na, K, NH_4): all soluble.
2. *Lithium:* soluble, except O and CO_3, sparingly soluble, and PO_4, insoluble.
3. Mg, Al: soluble: NO_3, Ac, H, Ci, SO_4, S.
4. Ca, Ba, Sr: soluble: NO_3, Ac, H, Ci, S; sparingly: O,
5. Hg (ic), Cu, Sn. } Soluble: NO_3, Ac, H, Ci, SO_4 (Mercuric iodid is insoluble)
6. Ag: NO_3, SO_4.
7. Pb: NO_3, Ac.
8. Bi, Sb: only soluble in form of double organic salts (e.g., Bismuth and Ammonium citrate; Antimony and Potassium Tartrate).
9. Mercurous: insoluble.

III. Strength of Watery Solutions in which commonly used salts may be prescribed.— It must be remembered that where several salts are prescribed in the same mixture, the solubility of each is apt to be lowered. The exact solubility will be found in another place.

The following table gives the amount of very commonly used drugs which can be safely prescribed in water to make 100 mils:

50 gms. (= ℥iv in water q.s.℥i). Tannin; Antipyrine, Acetate, Citrate, Salicylate, Iodide or Bromide of Potassium

or Sodium; $AgNO_3$; $ZnSO_4$; Chloral; Cocaine Hydrochloride.

5 gms. (= 25 grains in water q.s.℥i). Alum; Carbolic Acid; Borax; $KClO_3$; $NaHCO_3$; $HgCl_2$; Tartar Emetic; Quinine Bisulphate; Citrated Caffeine; the majority of the soluble salts of Alkalies, Earths and Metals.

Smaller Quantities: Boric Acid, 4; Morphine Sulphate, 4.5; Quinine Hydrochloride, 3; Quinine Sulphate, 0.13; Strychnine Sulphate, 2.

IV. Solubility in Different Media.

As a general rule, *inorganic substances* are more soluble in water than in alcohol. *Basic alkaloids* are insoluble in water, more soluble in alcohol. *Alkaloidal Salts* are soluble in either alcohol or water. *Gums* are soluble in water, insoluble in alcohol. *Resins* and *essential oils* are the reverse.

(In making mixtures, it must be remembered that spirits, tinctures, and fluidextracts all contain alcohol.)

Glycerin stands intermediate between alcohol and water as a solvent.

The following substances are:

1. *Practically insoluble in water.* Iodine, Calomel.
2. *Soluble in water, but almost insoluble in alcohol.* Alum, NH_4Cl, $KClO_3$, Tartar Emetic, $ZnSO_4$, Borax.
3. *Much more soluble in glycerin than in water.* Boric Acid, Alum, Carbolic Acid, $HgCl_2$.

INCOMPATIBILITY

Incompatibility means lack of agreement. It may be defined as that condition where two or more agents when brought together result in chemical decomposition, physical disassociation, or therapeutic opposition. In some cases the change may be desirable (white lotion, black wash), makes little if any difference, or may be undesirable. The change may result in precipitating or destroying certain drugs of the mixture, changing color only, forming new compounds without visible change or the ingredients may neutralize each other.

Incompatibility is usually classified as chemical, physical (pharmaceutic) and physiological or therapeutic.

Chemical Incompatibility occurs when a new chemical compound results (chemical change). It may, in general, be recognized in three ways: 1. Precipitation in which an insoluble precipitate is formed. 2. Effervescence or explosion — evolution of gas,— and 3. Change in color. In addition a new compound may be

formed without any apparent change in the appearance of the liquid with possible disastrous results.

In order to avoid this form of incompatibility some knowledge of the chemistry of the agents must be understood. A good working basis is that substances are incompatible if used as tests for each other, or if they are antidotes.

Physical or Pharmaceutic Incompatibility results in the production of mixtures of unsightly appearance due to physical changes. This is largely a question of solubility and often occurs when solids or liquids are added to solutions, thereby changing their densities. It occurs when there is a combination of such substances as are physically incapable of mixing. The most common physical incompatibilities result from mixing alcoholic solutions of resinous substances with water (fluidextracts, tinctures, spirits, etc., ginger, cannabis, camphor), but may not in any way effect the action of the drugs.

Physiologic or Therapeutic Incompatibility is where two or more drugs are prescribed which are antagonistic or contra-acting to each other, in which case they may almost exactly neutralize each other or one may weaken the action of the other. Arecoline and atropine are good examples, yet no two drugs exactly oppose each other throughout their entire range of action and some latitude is always permitted.

Incompatibility is a subject very much overdrawn and unnecessary stress is placed upon it. Although it is possible to find a large number of incompatibilities for any active chemical, but few of these are ever likely to be encountered in prescription writing; and according to Bastedo, of these few, the result not infrequently makes no practical change in the medicinal value or is deliberately desired. According to the same author, the following are those most likely to be encountered in the practical use of drugs:

I. Incompatibility Depending on Change of Solvent.

A. *Precipitate when added to Aqueous Liquids.* Substances in alcoholic solution and insoluble in water: as in spirits, fluidextracts, and tinctures, especially resinous ones, like tincture of cannabis, benzoin, myrrh.

B. *Precipitation when added to Alcoholic Liquids.* Substances in aqueous solution and insoluble in alcohol: as solutions of many salts (sodium sulphate, ammonium chloride) and mucilage of acacia. Mere insolubility as of oils or bismuth subnitrate in water, makes these really incompatible with the solvent.

II. Chemical Incompatibilities. Rule 1. Acids and salts of acid reaction are incompatible with alkalies and salts of alkaline reaction and the halogen salts.

Rule 2. Highly oxidized substances, like chromium trioxide (chromic acid), potassium permanganate, and potassium chlorate

are decomposed by organic matter. Potassium permanganate in solution turns brown; dry potassium permanganate or chromic acid may take fire or explode. Potassium chlorate, when rubbed with sulphur, hypophosphites, ammonium chloride, tannic acid or other organic substance, will explode violently.

Rule 3. Silver nitrate is incompatible with organic material and turns to black oxide or black metallic silver. With chlorides or hydrochloric acid it forms insoluble silver chloride.

Rule 4. (Mild mercurous chloride) calomel is incompatible with sodium carbonate and lime water. With the latter it makes a black precipitate of mercurous hydroxide, and forms "black wash," sometimes employed as an application to venereal sores.

Calomel is insoluble in water or alcohol, comparatively inert chemically, and bland to tissues.

Rule 5. Corrosive mercuric chloride (corrosive sublimate) is incompatible with iodides, many metallic salts, alkaloidal salts, tannic acid, lime water, and albumen.

With excess of lime water it forms a yellow precipitate of mercuric oxide, and forms "yellow wash," employed as an application to venereal sores. When the mercury salt is in excess, the precipitate is red oxychloride.

With soap, as on the surgeon's hands, its antiseptic power is destroyed.

With potassium iodide it forms mercuric biniodide. The iodide is of a brilliant scarlet color and dissolves in excess of potassium iodide. These two salts are often prescribed together to form the biniodide.

In albumen, as in white of egg or milk, we have the antidote when the drug is swallowed.

Rule 6. Lead acetate decomposes alum and other sulphates and the iodides, and tends to precipitate many organic substances, e.g., glucosides, from their solutions.

The admixture with alum makes Burow's solution. The precipitate of lead sulphate should be filtered out. The precipitate with the iodide is lead iodide of a brilliant yellow.

Rule 7. Ferric salts — (a) Make "ink" with tannic acid; (b) make blue to reddish or purple colors with compounds of the phenol group, such as phenol, resorcin, salicylates, etc.; (c) make red color with acetates; and (d) form a dirty brown precipitate with alkalies or alkaline salts.

Rule 8. Tannic acid is incompatible with alkaloidal salts, dry potassium chlorate (explodes), metallic salts, gelatin, and albumen. With ferric salts it makes "ink." For salts of alkaloids and antimony it is the local antidote.

It occurs in many vegetable drugs, and preparations of these may not only precipitate alkaloidal salts, but may change the gelatin coat-

ing of a pill or gelatin capsule to a tough leathery insoluble substance. Alcohol may prevent the precipitation of alkaloidal salts by tannic acid, as in tinctures.

Rule 9. Chloral hydrate decomposes to chloroform under the influence of strong alkalies; and when mixed with camphor, menthol, thymol, and similar substances, undergoes a physical change to a liquid.

Rule 10. Alkaloidal salts are incompatible with — (a) Alkalies — the precipitate is the pure alkaloid. (b) Tannic acid — the precipitate is the insoluble tannate. (c) Iodine, iodides, and bromides — precipitate is the iodide or bromide. (d) Mercuric bichloride — the precipitate is the insoluble double salt.

Quinine in addition is especially precipitated by salicylates and benzoates.

All these precipitates are more soluble in alcohol than water, so may not show in tinctures and other alcoholic liquids.

Rule 11. Glucosides are incompatible for the most part with lead acetate and tannic acid, and are decomposed by the mineral acids.

CHAPTER VI

PRESCRIPTION WRITING

Definition. A prescription is an order for medicine written by a physician or veterinarian to a pharmacist. It contains directions to the compounder and directions for the use of the drug. One prescribes just as much when he gives directions for regulating the diet, exercise, etc., as when he writes a prescription for one or more drugs to be given or applied locally, yet the word "prescription" is usually applied to a piece of paper on which there is written the order to the pharmacist. The term comes from the Latin *præ,* "before," and *scriptum,* "written," "written before."

It is customary to write prescriptions in Latin. The reasons for this may be given as: 1. It is a dead language and therefore not likely to change, and a prescription written in Latin is the same the world over and may be put up in a foreign country with equal facility. 2. The Latin name of a drug is distinctive and as a rule means only one drug. Furthermore, the botanical names of plants are usually given in Latin; first, because scientific men give them their names, and, secondly, because not infrequently the English name for a plant in one part of a country has an entirely different meaning in another. In the third place there is an element of secrecy which is often desirable to keep the owner or general public in ignorance of the character of the drugs prescribed, and there is less danger of "self doctoring" or using the prescription for some disorder or in some manner in which it would not be applicable. The difficulties of prescription writing are much overdrawn by the student or young practitioner for the following reasons:

1. Fear that he may not express himself clearly.
2. Distrust in his ability to make satisfactory combinations.
3. Fear that a faulty prescription will be criticised by the pharmacist.

A prescription consists of:

1. Superscription: The heading ℞.
2. Inscription: The ingredients and their amounts.
3. Subscription: Directions to the dispenser.
4. Signature: The directions to the patient or owner.

It should also contain the name of the patient, or owner, the date and name of the prescriber.

1. **Superscription.** The symbol ℞ (pronounced RX, but always written as a capital R with the tail crossed), is always placed upon the upper left hand corner preceding the names of the ingredients. This symbol is used as an abbreviation of the Latin verb *recipe,* which is the imperative of the verb *recipio,* I take. It means therefore, " take thou," and is always followed by the accusative case.

2. **Inscription.** The name and quantity of each ingredient. The quantity may be a weight, measure or number. In the typical compound prescription, the inscription contains 4 ingredients, *Basis* or principal drug indicated, *adjuvant,* which is aimed to help the *basis, corrective* which is desired to correct some disagreeable action of the basis and the *vehicle,* a substance which will give such form and consistence to the preparation as to make it pleasant and at the same time dilute the whole preparation to the proper proportion for measure. The true principles of a prescription as based upon a maxim of Asclepiades, *curare cito, tuto et jucunde,* is to cure quickly, safely, and pleasantly. Applied to a prescription we have this illustrated as

Curare (Cure) with the (Basis)
Cito (Quickly with the (Adjuvant)
Tuto (Safely) with the (Corrective)
et
Jucunde (Pleasantly) with the (Vehicle)

In veterinary practice the last factor (*pleasantly*) is often ignored and the principal use of the vehicle is to dilute the ingredients to the proper dosage. However, all animals object to dosing and the medicine should be made as little objectionable to them as possible.

3. **Subscription.** Directions for compounding, whether simply mixed or made into pills, ointments, etc. This may be written in full in Latin, but is usually abbreviated — M. for mix, Ft. — make, etc.

4. **Signature.** Directions for the label — to be placed there by the pharmacist. These are always preceded by the letter S. or Sig., which is an abbreviation of the Latin imperative *signa,* meaning with a label.

Then follows the signature of the prescriber.

There is a tendency in modern medicine to get away from the compound prescription and write one calling for but one drug. One containing only the basis is a simple prescription. On the other hand, in a compound prescription the agents may be neither adjuvant nor correctives to each other and yet make a good prescription.

In prescribing unusual doses of a powerful drug it is better to indicate that the quantities are correct, so that the prescription will not be refused by the druggist. This can be done by underscoring

the amount or better by writing after it the abbreviation Q.R. (Quantum Rectum).

General Hints on Prescription Writing. The following hints on prescription writing are taken from Sollmann: "When writing a prescription for a given condition, put down, first, the name of the best remedy. Ask yourself whether there is any other drug which may be employed to aid or usefully modify this. Put this down also. Then consider in which form the medicine should be administered, whether as liquid, powder, salve, etc. This will usually determine which preparation of the ingredient is to be employed. Put this down also. Then ask yourself what may be added to render the mixture agreeable to the patient. When this is written, all the ingredients will be represented. Now look over these carefully and see that there are no incompatibilities and that the constituents are soluble if the mixture is to be a liquid. Write the directions to the dispenser. Assure yourself that the prescription is grammatically correct, (especially the endings). Decide how many days the mixture is to be taken and how many doses a day. Decide whether the dose is to be a teaspoonful, tablespoonful, etc. By multiplying the total number of doses with the size of the single dose, ascertain the approximate size of the mixture. Round this off to a convenient figure. See page 9. Multiply the single dose of each ingredient by the total number of doses (again reducing the quantities to round numbers unless the constituent is very active). Check the doses. Write the directions to the patient (owner). Consider whether a *non-repetatur* is advisable. Affix your signature, the date, and the name of the patient."

The following prescription will illustrate the above.

		Single dose	No. of doses	Amount
℞	Tincturæ Aconiti	♏ xv	x 8	℥ ij
	Spiritus Ætheris Nitrosi.....	℥ ss	x 8	℥ iv
	Liquoris Ammonii Acetatis...	℥ ss	x 8	℥ iv
	Aquæ q. s. .....ad.	℥ ij	x 8	℥ xvj

In figuring the above prescription, we see that each dose of the mixture will be slightly more than one ounce. The next handy dose is two ounces. Consequently we decide upon that amount as the dose and add sufficient water (vehicle) to make eight two ounce doses.

In dispensing extemporaneous preparations about the same reasoning is used, except that the ingredients are mixed as you decide upon the remedies, instead of writing the names on paper. Of course, in every day practice the multiplication of single doses is carried out mentally and the product only written down.

The name of each ingredient is written upon a separate line and all important words are capitalized. The abbreviations and symbols mentioned under weights and measures, page 7, are used for the

quantities, followed by the Roman numerals for the required amount. Arabic numbers should not be used except to express fractions other than one-half.

GRAMMATICAL CONSTRUCTION OF PRESCRIPTIONS

The heading, inscription, and frequently the subscription, are written in Latin. A limited knowledge of this subject will enable one to write prescriptions properly. The Latin names of the drugs will be learned in Materia Medica and the principal difficulties will be in forming the correct endings of the ingredients and the directions to the pharmacist.

The following rules taken from Mann's Manual should enable one to write proper prescriptions:

Rule I. The noun expressing the name of the medicine is put in the genitive case when the quantity of it is to be expressed.

Rule II. If no quantity is expressed but a numeral adjective follows, the noun is put in the accusative.

Rule III. The quantity is put in the accusative case governed by the imperative *Recipe.*

Rule IV. Adjectives agree with these nouns in gender, number and case.

The accusative of the quantity is rarely written out in full, but is expressed by symbols. These rules may be illustrated by a literal translation of the following prescription:

℞ Tincturæ Opii ℥j (unciam unam)
Take Thou
of the Tincture of Opium one ounce.

RULES FOR FORMATION OF GENITIVE CASE

(Mann's Manual)

I. All nouns ending in *a* form the genitive in *æ,* as quinina, quininæ. Exceptions — *Physostigma, Physostigmatis, Coca* is unchanged. *Folia* is plural, Genitive *Foliorum.*

II. All nouns ending in *us, um, os, on,* form the genitive in *i* as Conium, Conii. Exceptions — *Rhus,* gen. *Rhois; Flos,* gen. *Floris; Erigeron,* gen. *Erigerontis; Fructus, Cornus, Quercus, Spiritus,* do not change.

III. All other nouns of whatever termination make the genitive in *s,* or *is, chloral,* gen. *chloralis.* Some lengthen the termination thus:

as genitive *atis* as Acetas,	Acetatis.
is genitive *idis* as Anthemis,	Anthemidis.
o genitive *onis* as Pepo,	Peponis.
x genitive *cis* as Cortex,	Corticis.

There are a few exceptions. *Asclepias,* gen. *Asclepiadis; Mas,* gen. *Maris; Phosphis, Sulphis,* etc., gen. *itis; Mucilago,* gen. *Mucilaginis; Solidago,* gen. *Solidaginis,* etc.

The following words do not change in their genitive:[1] *Amyl, Azedarach,* Berberis, *Buchu, Cajuputi,* Cannabis, *Catechu, Condurango,* Cornus, *Curare, Cusso,* Fructus, Digitalis, Hydrastis, *Jaborandi, Kino, Matico,* Quercus, *Sassafras, Sago,* Sinapis, Spiritus, Gambir, *Sumbul.*

It is only necessary to use the accusative of the nouns expressing the ingredients, when the quantity is omitted, and a numeral adjective takes its place. As before stated, the use of the appropriate symbols renders it unnecessary, as a rule, to write out in the accusative the words expressing quantity. The following simple rules for the formation of the accusative of these words are appended:

I. Nouns expressing quantity ending in *a,* are feminine and make the accusative singular in *am* and the plural in *as. Example,* Drachma, acc. sing. Drachman, pl. Drachmas.

II. Those ending in *um* or *us* make the accusative singular in *um.* The accusative plural of those in *us* is *os,* and of those in *um* is *a.* Those in *us* are masculine, those in *um* are neuter.

Congius, acc. sing. Congium, acc. pl. Congios
Granum, acc. sing. Granum, acc. pl. Grana.

The adjectives are declined like the nouns. The numeral cardinal adjectives are indeclinable except unus, duo and tres.

They are thus declined:

	Masculine.	Feminine.	Neuter.
Nom.	unus,	una,	unum.
Gen.	unius,	unius,	unius.
Acc.	unum,	unam,	unum.
Nom.	duo,	duæ,	duo.
Gen.	duorum,	duarum,	duorum.
Acc.	duos,	duas,	duo.
Nom.	tres,	tres,	tria.
Gen.	trium,	trium,	trium.
Acc.	tres,	tres,	tria.

The following is a list of some of the more frequently used numeral adjectives:

[1] Those in italics are indeclinable, those in *us* are of the fourth declension; the others are of the third. Apiol and Sumbul are given as indeclinable by some authorities. Dunglison gives Apiolum, i; Sumbul, i; Amyl, Amylis is given in the U. S. P.

	CARDINALS		ORDINALS	
1	I	Unus	1st	Primus
2	II	Duo	2nd	Secundus
3	III	Tres	3rd	Tertius
4	IV	Quattuor	4th	Quartus
5	V	Quinque	5th	Quintus
6	VI	Sex	6th	Sextus
7	VII	Septem	7th	Septimus
8	VIII	Octo	8th	Octavus
9	IX	Novem	9th	Nonus
10	X	Decem	10th	Decimus
11	XI	Undecim	11th	Undecimus
12	XII	Duodecim	12th	Duodecimus
13	XIII	Tredecim	13th	Tertius decimus
14	XIV	Quattuordecim	14th	Quartus decimus
15	XV	Quindecim	15th	Quintus decimus
16	XVI	Sexdecim	16th	Sextus decimus
17	XVII	Septendecim	17th	Septimus decimus
18	XVIII	Octodecim	18th	Octavus decimus
19	XIX	Novendecim	19th	Nonus decimus
20	XX	Vigenti	20th	Vicesimus
21	XXI	Vigenti unum	21st	Vicesimus primus
22	XXII	Vigenti duo	22nd	Vicesimus secundus
30	XXX	Triginta	30th	Tricesimus
40	XL	Quadraginta	40th	Quadragesimus
50	L	Quinquaginta	50th	Quinquagesimus
60	LX	Sexaginta	60th	Sexagesimus
70	LXX	Septuaginta	70th	Septuagesimus
80	LXXX	Octaginta	80th	Octogesimus
90	XC	Nonaginta	90th	Nonagesimus
100	C	Centum	100th	Centesimus

The verbs are nearly all used in the imperative mood, being addressed to the compounder. The following are some of the more common examples: *Recipe,* take; *Misce,* mix; *Signa,* mark; *Divide,* divide; *Mitte,* send; *Pone,* put; *Extende,* spread.

A few verbs are, however, in the subjunctive mood of mild command, taking the subject referred to in the nominative case, e.g., *fiat,* plural *fiant,* let be made. Detur, plural *dentur,* let be given. *Sufficiat,* may suffice. *Repetatur,* let it be repeated.

Only a few prepositions are commonly used: they are *ad,* to; *ana* (Greek), abbrev. *āā,* of each; *cum,* with; *in,* into; *ad* and *in* govern the accusative, *cum,* the ablative, and *ana,* the genitive cases.

The following phrases are commonly used: *Fiat lotio,* let a lotion be made. *Dividatur in partes equales,* let it be divided into equal parts. *Dentur tales doses,* let such doses be given. *Quantum sufficiat,* abbrev. *q. s.,* as much as may suffice. *Ne repetatur,* do not repeat.

LATIN WORDS AND PHRASES WITH THEIR ABBREVIATIONS AND ENGLISH EQUIVALENTS

WORDS OR PHRASES	CONTRACTIONS	ENG. EQUIVALENTS
Ad	Ad.	To, or up to.
Adde	Add.	Add.
Addantur	Add.	Let (them) be added.
Addendus	Add.	To be added.
Addendo	Add.	By adding.
Adjacens	Adjac.	Adjacent.
Ad libitum	Ad lib.	At pleasure.
Admove	Admov.	Apply.
Aliquot	Aliq.	Some.
Alter	Alt.	The other.
Alternis horis	Alt. hor.	Every other hour.
Amplus	Amp.	Large.
Ampulla	Ampul.	A large bottle.
Ana	A. or āā	Of each.
Aqua	Aq.	Water.
Aqua bulliens	Aq. bull.	Boiling water.
Aqua communis	Aq. com.	Common water.
Aqua fervens	Aq. ferv.	Hot water.
Aqua fontalis	Aq. font.	Spring water.
Aqua destillata	Aq. Dest.	Distilled water.
Aqua pluvialis	Aq. pluv.	Rain water.
Aut	Aut	Or.
Balneum vaporis	B. V.	Vapor bath.
Bene	Bene	Well.
Bibe	Bib.	Drink (thou).
Bis	Bis	Twice.
Bis in die, or dies	Bis die	Twice a day.
Bolus	Bol.	A large pill.
Bulliat or Bulliant	Bull.	Let boil.
Butyrum	But.	Butter.
Calefactus	Calef.	Warmed.
Cape	Cap.	Take (thou).
Capiat	Cap.	Let him take.
Caute	Caute	Cautiously.
Charta	Chart.	Paper (medicated).
Chartula	Chartul.	A small paper for a powder.
Cibus	Cib.	Food.
Cochlear or Cochleare	Coch.	A spoonful.
Cochleare amplum	Coch. amp.	A dessertspoonful.
Cochleare magnum	Coch. mag.	A tablespoonful.
Cochlear parvum	Coch. parv.	A teaspoonful.
Cola, Colatus	Col.	Strain, strained.
Collutorium	Collut.	A mouth wash.
Collyrium	Collyr.	An eye wash.
Coloretur		Let it be colored.
Compositus	Comp.	Compound.
Congius	Cong.	A gallon.
Conserva	Cons.	A conserve, *also* Keep (thou).
Contusus	Contus.	Bruised.
Cortex, corticis	Cort.	The bark.
Cras, crastinus	Crast.	To-morrow.

WORDS OR PHRASES	CONTRACTIONS	ENG. EQUIVALENTS
Cujus, cujus-libet	Cuj.	Of which, of any.
Cum	C.	With.
Cyathus, vel Cyathus vinarius	Cyath, C. vinar.	A wine-glass.
Da, detur	D., det.	Give, let be given.
De	De	Of or from.
Debitus	Deb.	Due, proper.
Decanta	Dec.	Pour off.
Decem, decimus	Decem.	Ten, the tenth.
Decoctum	Decoct.	A decoction.
Decubitus	Decub.	Lying down.
De die in diem	De d. in d.	From day to day.
Dein vel Deinde	Dein.	Thereupon.
Deglutiatur	Deglut.	Let be swallowed.
Dentur tales doses No. iv.	D. t. d. No. iv.	Let four such doses be given.
Diebis alternis	Dieb. alt.	Every other day.
Diluete, Dilutus	Dil.	Dilute (thou), Diluted.
Dimidius	Dim.	One-half.
Divide	Div.	Divide (thou).
Dividatur in partes æquales.	D. in p. æq.	Let it be divided into equal parts.
Dividendus-a-um	Divid.	To be divided.
Dolor	Dolor	Pain.
Dosis	D.	A dose.
Drachma	Dr. or ʒ	A dram (60 grains).
Eadem (fem.)	Ead.	The same.
Ejusdem	Ejusd.	Of the same.
Electuarium	Elect.	An electuary.
Enema	En.	A clyster or enema.
Et	Et	And.
Extende	Ext.	Spread.
Extende supra	Ext. Sup.	Spread upon.
Extrahe	Extrahe	Extract (thou).
Fac, Fiat, Fiant.	F.	Make.
Fac Tales Dosis.	F. T. D.	Make such doses.
Fac pilulas duodecim.	F. pil. XII.	Make twelve pills.
Farina		Flour.
Fervens	Ferv.	Boiling.
Fiat	Ft.	Let be made (sing.).
Fiant	Ft.	Let be made (plu.).
Filtra	Filtra	Filter (thou).
Fluidus	Fluid., Fl.	Liquid.
Gargarysma	Garg.	A gargle.
Gradation	Grad.	By degrees, gradually.
Granum, Grana	Gr.	Grain, grains.
Gutta, Guttæ	Gtt.	A drop, drops.
Guttatim	Guttat.	By drops.
Haustus	Haust.	A draught.
Hebdomada	Hebdom.	A week.
Herbarum recentium	Herb. recent.	Of fresh herbs.
Hic, Hæc, Hoc	Hic, Hæc, Hoc.	This.
Hirudo	Hirudo	A leech.
Hora	H.	An hour.
Idem	Id.	The same.
Imprimis	Impr.	First.

WORDS OR PHRASES	CONTRACTIONS	ENG. EQUIVALENTS
In dies	Ind.	Daily, or from day to day.
Infunde	Infun.	Pour in.
Infusum	Infus.	An infusion.
In Pulmento		In gruel.
Instar	Instar	As big as, the size of.
Inter	Inter	Between.
Internus, -a-um	Int.	Inner or internal.
Intus	Intus	Inwardly.
Jam	Jam	Now.
Juxta	Juxta	Near to.
Lac, Lactis	Lac.	Milk, of milk.
Libra	Lb., or lb.	A pound.
Linimentum	Linim.	A liniment.
Linteum	Lint.	Lint.
Macera	Mac.	Macerate.
Magnus	Mag.	Large.
Mane	Mane	In the morning.
Massa, massa pilularis		A mass, a pill-mass.
Matutinis	Matut.	In the morning.
Medium	Med.	Middle.
Mensura	Mensu.	By measure.
Minimum	♏ or min.	A minim.
Misce	M.	Mix.
Mistura	Mist.	A mixture.
Mitte	Mit.	Send.
Modo præscripto	Mod. præsc.	In the manner prescribed.
More dictu	Mor. dictu	In the manner directed.
More solito	Mor. sol.	In the usual manner.
Necnon	Necn.	Also.
Ne trades sine nummo	Ne. tr. s. num.	Do not deliver without the money.
Nisi	Nisi	Unless.
Non	Non	Not.
Non repetatur	Non repetat.	Let it not be repeated.
Nox, Noctis	Noc. or noct.	The night, of the night.
Numero	No.	In number.
Octarius	O. or Oct.	A pint (℥xvj).
Octavus		Eight.
Octo	Octo	Eight.
Omni hori	Omn. hor.	Every hour.
Pars, Partis	Par., Pt.	A part, of a part.
Partes æquales	Pt. æq.	Equal parts.
Parvus		Little.
Pastillus	Pastil.	A pastille.
Penicillum camelinum	Pencil. cam.	A camel's hair pencil or brush.
Per	Per	Through, by.
Phiala	Phil.	A vial or bottle.
Phiala prius agitate	P. P. A.	The bottle having been first shaken.
Pilula	Pil.	A pill.
Poculum	Pocul.	A cup.
Pondere	P.	By weight.
Post cibo	Post cib.	After eating.
Potus	Potus	Drink.

WORDS OR PHRASES	CONTRACTIONS	ENG. EQUIVALENTS
Primus	Primus	The first.
Pro	Pro	For.
Pro re nata	P. r. n.	Occasionally, according to circumstances.
Pulvis	Pulv.	A powder.
Quadrans, -antis	Quad.	A quart.
Quantum libet	Q. lib.	As much as you please.
Quantum sufficiat	Q. s.	As much as is necessary.
Quaque	Qq.	Each, or every.
Quaque hora	Qq. H.	Every hour.
Quartus	Quart.	Fourth.
Quattuor	Quat.	Four.
Quinque	Quinq.	Five.
Quintus	Quint.	The fifth.
Quorum	Quor.	Of which.
Quotidie	Quotid.	Daily.
Ratio		Proportion.
Recens, -entis	Rec.	Fresh.
Recipe	℞	Take.
Reductus in pulverem	Red. in pulv.	Let it be reduced to powder.
Reliquum	Reliq.	Remaining.
Repetatur	Rept.	Let it be repeated.
Retinere	Retin.	To keep.
Saltem	Saltem	At least.
Saltim	Saltim	By leaps.
Saturatus-a-um	Sat.	Saturated.
Scatula	Scat.	A box.
Scrupulum	Scrup. or ℈	A scruple (20 grs.).
Secundem artem	S. A.	According to art.
Secundus	Secund.	Second.
Semel	Semel	Once.
Semis or semissis	Ss.	A half.
Septem	Sept.	Seven.
Septimana	Septim.	A week.
Sescuncia		An ounce and a half.
Sesquihora		An hour and a half.
Sex	Sex	Six.
Si	Si	If.
Si Opus Sit	Si Op. Sit	If necessary.
Signa	Sig.	Write, or mark (thou).
Signatur nomine proprio	Sig. nom. pro.	Let it be written with its proper name.
Simul	Simul	Together.
Sine	Sin.	Without.
Singulorum	Sing.	Of each.
Sit	Sit	Let it be.
Solus	Sol.	Alone.
Solve	Solv.	Dissolve.
Somnus	Somnus	Sleep.
Statim	Stat.	Immediately.
Subinde	Subind.	Frequently.
Sumat talem	Sum. tal.	Let him take one like this.
Sume	Sum.	Take.
Supra	Supra	Above.
Tabella	Tab.	A tablet.

WORDS OR PHRASES	CONTRACTIONS	ENG. EQUIVALENTS
Talis	Tal.	Such a one.
Ter	Ter.	Thrice, or three times.
Ter in die, or Ter die	T. i. d. or T. D.	Thrice daily.
Tero	Tero	I rub.
Tere simul	Tere sim.	Rub together.
Tertius	Tert.	Third.
Tres	Tres	Three.
Triduum	Trid.	Three days.
Tritura	Trit.	Triturate.
Troschiscus, Trochisin	Troch.	A lozenge or troche.
Tussis	Tus.	A cough.
Ultimo (or Ultima) præscriptus	Ult. præsc.	The last ordered.
Una	Una	Together.
Uncia	Unc. or ℥	An ounce.
Ut dictum	Ut dict.	As directed.
Vehiculum	Vehic.	A vehicle or menstruum.
Vel	Vel.	Or.
Vesper, -eris	Vesp.	The evening.
Vinum	Vin.	Wine.
Vitellus	Vitel.	Yolk.
Vitreum, Vitrum	Vitr.	Glass.
Volatilis, -is, Volatile	Volat.	Volatile.

LIQUID PRESCRIPTIONS

Liquid medicines intended for internal use only are always administered by measure, hence it is customary to make the total quantity of the prescription such that each dose will be a teaspoonful, dessertspoonful, tablespoonful (℥ss), one ounce, two ounces, etc., without regard to the quantity of drugs present. The difference between the actual dose of the active ingredients and the actual dose of the mixture is made up by the vehicle. For this reason the vehicle is therefore varied to make the total number of easily measured doses desired. Thus we say relative to amount of vehicle desired: q.s. ad ℥ij–iv, etc., or as much as may be needed to make the amount decided upon, without any regard to the amount of drugs present.

The reason for this custom will be readily seen from the following prescription. Suppose we wish to give 1 dram of fluidextract of Nux Vomica at each dose together with four drams of Fowler's Solution, in all 16 doses. Then we would have:

℞ Fluidextracti Nucis Vomicæ ..... ℥ ij
Liquoris Potassi Arsenitis ..... ℥ viij
Aquæ q. s. ..... ad. ℥ xvj
M. et Sig.
2 Tablespoonfuls. T. I. D.

This prescription then calls for 16 ounce doses each containing 1 dram of Fluidextract of Nux Vomica and half ounce doses of Fowler's Solution, while if it should be written:

℞ Fluidextracti Nucis Vomicæ..... ℥ ij
Liquoris Potassii Arsenitis..... ℥ viij

the total amount of mixture would be 10 ounces. This could not be easily divided into sixteen doses, and the dose would not conform to the usual measures, and furthermore would require careful calculation.

Prescriptions containing solids and liquids show this necessity more prominently than those of liquids alone, because we cannot tell just how much volume the dissolved solid will have.

Furthermore, such quantities make irregular amounts and do not correspond to usual and standard bottles.

In figuring the quantities, although domestic measures vary, we may assume that an ounce bottle will hold eight teaspoonful doses, or two tablespoonful doses, a two ounce bottle, fifteen or sixteen teaspoonful doses, a four ounce bottle, 30 teaspoonfuls or eight tablespoonfuls, and an eight ounce bottle, 15–16 tablespoonfuls, etc.

PERCENTAGE SOLUTIONS

Although making percentage solutions is a simple matter of arithmetic, the subject is difficult for many to grasp. There are various ways of figuring the correct amount, some of which may be illustrated as follows:

Figuring the amount for one ounce and multiplying by the total number of ounces. Thus:

1 ounce=8 drams=480 minims. 1 per cent. of 480 minims is 4.8 minims; for ordinary purposes, 5 minims. In other words, there are 4.8 minims of substance in one ounce of a 1 per cent. solution. When this amount is obtained any amount may be easily figured for stronger solutions or for larger quantities.

After a little experience, a prescriber will remember that 4.8 minims (for ordinary purposes 5 minims) are required to make one ounce of a 1 per cent. solution. Then deductions are easily made for other strength solutions and for various amounts.

In making absolutely correct percentage solutions all items must be weighed or measured, not weighed and measured in the same preparation. The weight of 480 minims of water under standard conditions is 454.6 grains. Therefore 4.8 grains of substance with enough water to make an ounce is not absolutely a 1 per cent. solution by weight or volume, but such exactness is rarely necessary, and it is sufficient to carry in mind that 4.5 grains (4.546 grains), practically 5 grains, is the quantity of substance required to make 1 fluid ounce of a 1 per cent. aqueous solution of solids. For ordinary purposes it is sufficient to calculate on the basis of 500 minims or grains to the ounce.

Percentage Solutions in the Metric System. Since the

metric system is one of decimals, percentage solutions are very easily obtained or calculated. It is a simple matter of multiplication and may be worked out by multiplication. Thus to get a 5 per cent. solution of any substance means 5 grams or 5 mils of the substance, with enough solution to make 100 mils. Other quantities may be figured in the same way.

CHAPTER VII

INTRODUCTION TO PHARMACOLOGY

ACTION OF DRUGS

Drugs produce their action in a living organism by either increasing, decreasing or stopping one or more functions of the body, and when used in the treatment of disease are almost always used upon this principle. The action or changes produced in a living organism may be of a chemical or physiologico-chemical nature. Most drugs unite with some constituent of the organism and by virtue of this union change its functions. Some, such as the neutral salts, act in great part through their physical relations to the tissues and it is due to this fact that the salines produce purgation by drawing water from the blood into the intestines.

Local Action. A drug may produce alteration in the function of a part before entering the circulation. These changes may be loss of sensation (Anesthesia), inflammation, etc., with its symptoms of necrosis and astringent effect, in this way constituting what is termed local effect. The changes produced after a drug has entered the circulation are known as *general* or *systemic* effects. There are a few other terms that should be explained. *Remote actions* occurring in distant parts of the body (may be systemic or indirect). *Direct* or *primary* effects are produced by the direct action of the drug on the parts involved. *Indirect* effects (sometimes called secondary effects) are not produced by the action of the drug upon the tissue concerned but by the intervention of some other structures on which the drug acts. *Immediate* effects (also called primary) are the effects resulting at once. *Late* effects are those occurring later. If preceded by other immediate actions they are properly called secondary actions.

Factors Which Modify Action of Drugs. The factors which modify the action of drugs are: weight, age, sex, temperament, habits, idiosyncrasy, nature of disease, object of medication, form of remedy, method of administration, time of administration, and frequency of administration.

1. *Body Weight.* It is obvious that it would be a good practice to administer a definite dose according to the weight of the animal, as is done in a pharmacological investigation, but it is not convenient to weigh animals in all cases and very difficult to estimate the exact weight. This method has been attempted, taking the weight of the

horse at 1000 lbs. as 1, and estimating the dose for weights higher and lower than this, but has not proven very practical and aside from varying the dose for large and small animals, is of little practical use.

2. *Age.* The age of the animals is of considerable importance, but with the exception of a few drugs, which act more violently on young animals, is largely lost sight of, except as the dose is graded according to size. Weight is of more importance in veterinary dosage than age, because this varies so greatly in different kinds of each species handled.

3. *Sex.* In human practice women require less medicine than men, on account of smaller size and greater susceptibility to any influences. In animals we do not see this difference, but irritant cathartics should be avoided during pregnancy on account of the liability to produce abortion.

4. *Temperament — Race.* High strung animals are more susceptible than phlegmatic ones. This is particularly so in case of drugs acting upon the nervous system. The thoroughbred or standard bred animals are much more susceptible than the draft type.

5. *Tolerance, Habit.* This is of little importance to veterinarians, as their patients are not addicted to drug habits, but we do occasionally find a horse which has been fed arsenic in sufficient amounts to become very tolerant to it.

6. *Idiosyncrasy.* This means an unusual reaction to a medicine or food. We occasionally find an animal in which ordinary doses of a medicine will produce an unusual reaction, or one in which extremely large doses are necessary to cause the usual reaction. There are also some animals which must not be fed certain foods on account of disagreeable effects due to a peculiar susceptibility to them.

7. *Species.* On account of the structural and physiological variations in the different species of animals, the actions of drugs are not the same for all species. For instance, emetics do not usually produce emesis in horses, opium and its alkaloids cannot be depended upon to produce sedative action in the horse and always produce excitement in the cat family. Dogs are very tolerant to morphine, but very susceptible to strychnine. Purgatives take much longer to act in the herbivora than in the carnivora or omnivora, etc.

8. *Nature of disease.* The nature of the disease has considerable influence upon the action of drugs. For instance, the usual sedatives may have little effect in quieting the severe pain of enteritis. Antipyretics reduce temperature in fever, but not when it is normal. In some febrile conditions, especially influenza of horses, the usual purgative dose of aloes is liable to cause superpurgation.

9. *Object of medication.* This may be illustrated by several drugs. Quinine is given in much smaller doses as a bitter than as an antipyretic, ipecac and apomorphine in smaller doses as expectorants

than emetics, strychnine in larger doses as a stimulant than as a tonic.

10. *Form of medicine.* In general, liquids are more active than solids, and alcoholic liquids more than aqueous. Active principles are more soluble than crude drugs, powders and dry filled capsules than pills, uncoated pills than coated ones, and tablet triturates than compressed tablets.

Besides the above, there are some cathartic drugs which are more active than their active ingredients (aloes, cascara); this is probably due to the presence of the extractive matter which retards absorption and keeps the active principles in the alimentary tract until they reach the colon.

11. *Channel of administration.* It has been usually considered that the hypodermic dose is half the oral, and that of the rectum twice that of the mouth. However, in a number of instances, drugs are absorbed from the rectum as rapidly as from the stomach, or more quickly even, and some drugs are absorbed from the stomach and duodenum (dogs, at least), with sufficient rapidity to give effect in a short time. The rate of absorption of different drugs from the various channels differs so greatly that no absolute rule can be applied. Furthermore, since these methods of administration are resorted to only on special occasions their amounts should be about the same. In intravenous medication the dose is small because the drugs are injected directly into the circulation.

12. *Time of administration.* This is not of any great importance in large animal practice, because the stomachs of herbivora are never empty. In the carnivora and omnivora the action is usually more rapid if given before a meal, because the medicine will not be diluted with the food in the stomach.

13. *Frequency of administration.* It is impossible to give any rule for repetition of doses. In general, drugs which produce action very rapidly require frequent doses to maintain their action, while those which act slowly are not often given more than two or three times daily. It is obvious that the dose of a potent drug is less if it is given at frequent intervals than at longer ones.

METHODS OF ADMINISTRATION

Orally, subcutaneously or hypodermically, intramuscularly, intratracheally, intravenously, inhalation, per rectum, endermic.

1. *Orally, per mouth, per os.* This is the most common way of administering medicines. If given for action upon the stomach, drugs should be administered some time before a meal, because the gastric juice may cover the mucosa to such an extent as to interfere with the action of the drug. A very powerful or poisonous medicine should be given during or after a meal, so that the absorption will

not be so rapid; for instance, arsenic or strychnine in large doses. In case of the herbivora this is not so important, as their stomachs are rarely, if ever, empty.

2. *Hypodermic, subcutaneous, hypodermatic.* This is the next most common method. The medicine is injected beneath the skin. Any place may be selected where the tissues are not too dense, although the injections are usually made upon the neck or in some other place where the skin is thin. One should be careful not to insert the needle into a blood vessel. If this should occur, withdraw the needle and insert it again. The usual antiseptic precautions should be taken to avoid abscess formation. Absorption from the subcutaneous tissues is fairly rapid and may be aided considerably by massage of the part, so that the medicine comes in contact with a greater area for absorption. In cases of edema this method is not very effective, since absorption is slow.

3. *Intramuscularly.* In this case the needle is plunged through the skin and subcutaneous tissues directly into the muscles. Absorption is very rapid in this case.

4. *Intratracheally.* This method is more rapid than the hypodermic, as absorption is very rapid from the pulmonary capillaries. One should avoid strong irritants and those materials which are not easily absorbed. The injection is made with a hypodermic needle through the intercartilaginous space.

5. *Intravenously.* This is the most rapid of all and the material is not influenced by the body fluids, as the medicine is injected directly into the blood stream.

Precautions should be taken to have the medicine at about the body temperature and to have all the air expelled from the syringe. The danger is also lessened if the injection is made slowly.

6. *Per rectum: Enema, Clysters, Lavement.*

Enemata are of use for the following purposes:

1. To influence the general system through rectal absorption or other purposes.

2. Act locally upon disease of the parts.

3. For their mechanical effects. (Dislodge feces and parasites.)

Where general absorption is desired a small amount of liquid should be used, as it is desired that the animal retain the injection. If for the discharge of feces or parasites a large amount should be used. One should use reasonable care not to rupture the walls of the rectum and not give too frequently lest they set up undesired straining and irritation.

7. *Inhalations.* These, with the exception of general anesthetics, are generally employed in diseases of the respiratory tract. The most common method is that of steaming.

8. *Endermic.* There are four methods:

A. *Inunction.* External applications upon the skin or injured

places of agents applied with fat or fatty substances for local purposes.

B. *Enipidermic.* Medicines placed upon and kept in contact with the skin, no friction being used. (Solutions of the alkaloids in oleic acid, chloroform.) The agents pass through the skin with ease by osmosis. Aqueous and alcoholic agents are but little absorbed in this manner. Aqueous solutions are not absorbed from the skin unless volatile or caustic, because the stratum corneum of the skin is impermeable to water, and absorption from the skin must therefore take place from the glands which prevent the absorption of water, but not of other fat.

C. *Epidermic.* Friction is used to promote the absorption or passage of the medicant through the skin, as in the case of the mercurial ointments.

D. *Endermatic.* Cuticle removed by blistering and the drug powdered upon the surface.

Relative Size of Doses. The following table shows the relative size of doses for the different methods of administering medicines, taking the oral dose as 1:

Mouth, 1
Subcutaneous, ½
Rectum, 2
Intravenous, ¼
Intratracheal, ¼

Relative Doses for Different Species of Animals. Fish gives the following table of doses:

Horse, 1	Swine, ⅛
Cow, 1½	Dog, 1/16
Sheep and goat, ⅕	Cat, 1/32

These ratios are only approximate and one must take into consideration the size of the animal and the effect of the different drugs upon different species of animal. The doses for horses and cattle are given as the same in most cases throughout the text, and of course mean the average dose.

HISTORY OF THERAPEUTICS

Therapeutics probably dates back to prehistoric time, when man cared for his own ills and those of his family and animals. He no doubt chose his remedies from the surrounding vegetation much in the same way as his food. That is, he tried many things in the hope that some would be of benefit. The Bible contains many references to medicine, and the Laws of Moses may be regarded in the light of the first meat inspection law.

In the early days of medicine the priests were the physicians and ministered to both body and soul. Their remedies and practices were closely associated with religion and mysticism. They obtained their knowledge from others, from records in the temples, and from experience. No thought was given as to why certain remedies should be used in certain conditions or as to the cause of the disorder. Disease was often regarded as an evil spirit or entity and often something disgusting was given with the hope of driving it out of the body, or some performance gone through to strike terror to it and make it leave the place.

After a while the practice of medicine became too large for the priests to look after, so a new class arose, who looked after the bodily ills and gave the priests full power to look after the spiritual welfare of man. Hippocrates was one of the first physicians, and is said to be the father of medicine. He gained much of his knowledge from the records in the temples, was a close observer and voluminous writer. He believed in the theory of the four cardinal humors, blood, yellow bile, black bile and mucus or phlegm, and of coction and crisis. By coction was meant a thickening or elaboration of the humors of the body, which was sometimes necessary for their elimination. Disease was regarded as a combination of phenomena resulting from the conservative principles of life to effect a coction, in other words, a combination of the death producing elements in such a manner that they could be eliminated. Crisis was regarded as the time of union and was considered as critical. This being obtained by coction, it was only necessary to evacuate the deleterious material. The seventh day was often considered the critical day and the time for medicinal interference. Depleting drugs were used at that time (emetics and purgatives) to aid in the elimination. Although this theory dates back to early days, we often hear the laity speak of the humors of the blood, a thing commonly believed, and still exploited by many patent medicine concerns. It is not so long, either, since the practice of roweling horses was in vogue. This consisted of inserting some dirty material under the skin, to cause the formation of pus, which was then considered as so much poison that had been brought to the part and was being thrown off.

Remedies were chosen solely by their recommendation and reputation and no attention was given to their method of action. They were used because it was customary to use them in certain conditions. In the effort to enlarge the number of medicines, many were tried. It was noticed that most drugs of any medicinal value were bitter. This accounts for a large number of preparations which have no other virtue. Then, in some cases it was only necessary to have a plant resemble in shape some anatomical structure of the body to have it lauded as a panacea for all diseases of that organ. (Hepatica — Lungwort, etc.)

The alchemists (chemists) while searching for something that would turn all metals into gold and cure all diseases proposed a number of remedies. They made extensive trials upon the well and sick, and it is said that antimony was so named from is disastrous effects upon the brother monks of the discoverer.

Gunshot prescriptions were soon in vogue. They contained a great number of remedies and were given in the hope that some of them would benefit the patient. If he survived, credit was given the medicine for a cure. If he died, it was attributed to the severity of the disease. Those usages led to a state of nihilism, from which Hahnemann developed the system of homeopathy and the rule *Similia similibus curantur.* Symptoms alone were treated and little if any attention was given to the disease itself. Hahnemann also believed that by trituration, and dilution or shaking, medicine could be made more powerful for good effect. While there were many fallacies in this method, it proved of service to rational medicine, because it demonstrated that disease tends to recover without the intervention of drugs. One of the next steps in therapeutics was that of total freedom from drugs, which dates back to 1745. Skoda (1805–1881), one of its strongest advocates, was the founder of the methods of auscultation and percussion and really benefited the science which he sought to destroy.

With the isolation of the alkaloids (Morphine, 1817,) and animal experimentation, the science of pharmacology, or action of drugs, has developed and put medicine upon a more rational basis.

METHODS OF TREATMENT

The methods of treatment may be conveniently divided into expectant, specific, symptomatic, empirical and rational.

Expectant therapeutics means the absence of any real treatment beyond general principles of hygiene, rest and diet. This form of treatment is often necessary when it is desired to let the disease progress for diagnostic purposes or whenever nothing better is known. If any medicine is given, it should be the aim to prescribe something that will have a tendency to favorably influence the disease, and not something that might possibly do harm. A *placebo* is often prescribed for this purpose. The real object of a placebo in veterinary medicine is to keep the owner or attendant satisfied that something is being done for the animal.

Specific. Specific treatment directly attacks the disease or its cause. In such cases treatment is determined as soon as a diagnosis is made. (Salicylates in rheumatism, iodine in actinomycosis, etc.)

Symptomatic. In this case the symptoms alone are treated, without any regard as to their cause. Symptomatic treatment may be indicated in some cases, but not in others. It may be possible

to favorably influence the course of the disease by treating symptoms in some cases, or the symptoms may be so severe or lead to such disagreeable secondary effects that their removal is desired. At other times, it may be necessary to remove them, in order to prolong life, so that other treatment may be used later. Purely symptomatic treatment is not good therapeutic usage because it is frequently undesirable to remove symptoms (cough when there is considerable exudation, etc.) which may be purely a physiological way of overcoming the condition. Furthermore the removal of symptoms often masks the course of the disease to such an extent that it is difficult to know whether an animal is improved or only a few of the symptoms have been removed.

Rational Therapeutics. This makes use of the other groups, but aims at the removal or destruction of the cause of the disease, and to favorably influence its course by treating the clinical manifestations as they arise.

Rational therapeutics may be further divided as follows:

1. To deal with the specific organism.

    (a) Destroy or remove the cause of the disease.
    (b) Avoid the cause.
    (c) Protect the animal from the cause.

2. Treat the clinical manifestations.

Destroy or Remove the Cause. This is largely followed in the field of specific infections, but is also largely indicated in other diseases. For instance, we use vermicides and vermifuges to destroy and expel specific parasites; laxatives, to remove injurious substances from the bowels or to overcome a paresis or torpidity; purgatives, to flush out irritant material from the intestines which may be causing diarrhea instead of locking the irritant in with astringents. The same holds true in the use of emetics in cases of poisoning or overloading the stomach in small animals or in the administration of chemical antidotes for the treatment of poisoning. The same theory is used in the treatment of local infections, where disinfectants and drainage are used to destroy and remove infection.

Avoid the Cause and Protect from the Cause. These two divisions may conveniently be discussed together. Like the preceding, they are largely employed in infectious diseases, but at the same time may be used in everyday practice. The surgeon cleans and disinfects his hands, instruments and field of operation with absolutely no other idea in mind than to avoid and protect against infection, i.e., the cause of future trouble. The sanitarian protects sound animals from the various infections by quarantine, disinfection, vaccination or any other means of sanitation. These measures are not confined to infectious diseases, but are to be employed in many other conditions. They may mean the avoidance of certain foodstuffs or

water which appear to be the cause of disease, whether infectious or not, or the restriction or change of diet in certain cases.

Clinical Manifestations. The treatment must often be regulated according to the clinical manifestations, and falls back upon the symptomatic administration of drugs, but does not mean symptomatic treatment in the true sense of the word. The therapeutist must be a good observer and use drugs only when necessity arises. He must use good drugs, know when to use them, how to use them and last, but not least, when not to use them. He must realize that any drug which has the power to benefit the patient if used in the right condition has just as much power to injure it when used in the wrong condition. He should be careful not to ascribe all the improvement of a patient as due to the action of drugs but to give nature some credit for it.

USE OF DRUGS IN DISEASE

For the scientific treatment of disease, it is necessary for the therapeutist to have an accurate knowledge of the action of drugs, know what action he desires and use great care in making his selection. A drug should not be prescribed until it is known just what action is desired and unless there is a distinct indication for it. The old habit of giving " shot gun " or " blunderbuss prescriptions " has no place in modern therapeutics, but has been replaced by those containing one or two drugs whose action is known.

With the advancement of medicine the stock or semi-proprietary prescriptions for certain diseases, or the use of certain drugs in certain diseases, with the exception of a few specifics, has fallen into disuse. Stock prescriptions are convenient and often all that is required, but in serious conditions, and with the modern methods of diagnosis, it is better to treat each case individually, and to treat the complications as they arise.

It is evident, therefore, that a complete knowledge of pharmacology or the action of drugs is necessary.

What Should We Learn About Drugs? It is a problem to determine just what should be learned about drugs, because the subject of materia medica is so extensive. There are many things impossible and unnecessary to learn. Thus it is not necessary to learn the pharmacopœial definition, place of growth, manner of collection and preparation, physical properties except of the more important ones, microscopic anatomy, melting points, adulterations, tests, etc. These are all valuable data for the pharmacists and chemists upon whom we must depend for our medicines.

We should, however, learn,

1. *The official English and Latin name, and common synonyms*

because the Latin name is used in prescription writing and the English name and synonyms are used in literature.

2. *Source.* So far only as some of the most important drugs are concerned.

3. *Characteristics.* Of only the most common and easily determined drugs. Form, color, taste, etc.

4. *Composition of the inorganic.* So far as the composition would influence its use or compatibility.

5. *Active ingredients* of organic preparations: alkaloids, glucosides, resins, etc. It is necessary to know upon what a drug depends for action, as well as the source of some of the principles which are used alone. The composition is also important from the standpoint of compatibility.

6. *Solubilities.* So far as is concerned in the use of drugs.

7. *Incompatibilities.* The incompatibilities that are of importance in prescribing or using the drugs should be known. See incompatibilities, page 45.

8. *Form in which drugs may be obtained and administered.* Preparations and their strengths and doses, especially of the official and more commonly used unofficial preparations.

9. *Physiologic or pharmacological action.* Method by which the drug acts. Its action externally and locally, and upon the various systems of the body.

10. *How it is absorbed and how eliminated.*

11. *Untoward or side actions.* Whether there are any untoward or side actions which must be looked after.

12. *Toxicology.* The symptoms and treatment of poisonous doses, antidotes, etc.

13. *Uses or therapeutics.* The uses can only be briefly pointed out in materia medica or pharmacology. The details should be worked out in the treatment of disease.

14. *Contraindications.* Conditions in which certain drugs are not indicated or in which they might do harm if given.

15. *Administration.* In what way, in what form and how often to use for different purposes.

CHAPTER VIII

DRUGS ACTING UPON THE CIRCULATORY SYSTEM

These may be roughly divided into (1) circulatory stimulants, (2) circulatory depressants, (3) vasodilators and (4) vasoconstrictors. The circulatory system consists in the main of the heart or pumping organ and the blood vessels. The action of the heart consists of a rhythmical contraction (systole) and dilatation (diastole). The blood is under positive pressure during systole and under negative pressure during diastole, corresponding respectively to the forcing and sucking action of a pump. The pause or period of rest is very important because it gives opportunity for rest and recuperation of the organ, while the valves serve to regulate the flow of blood. The nerves of the heart are the vagus or inhibitory and the sympathetic or accelerator. There are also some automatic intracardiac centers. The heart muscle and nerves may be stimulated by mechanical, chemical, thermal and electrical means, while the heart may be paralyzed or depressed by drugs, disease of the myocardium, overexertion, deficiency of oxygen, lack of nourishment and collection of carbon dioxide and other products of decomposition in the blood.

1. CIRCULATORY STIMULANTS

These are agents which increase the efficiency of the heart. They may increase the force of the beat and lessen the rate, or may increase both the force and rate. The best examples of those increasing the force but decreasing the rate belong to the digitalis group and are:

Digitalis	Squill
Strophanthus	Apocynum (Canadian Hemp)
Convallaria	Adrenaline
Adonis Vernalis	Strychnine

Those increasing both rate and force are:

Caffeine	Atropine

There are several drugs which reflexly stimulate the heart and increase the number of beats, increasing the output of the heart per unit of time. Their effect, however, is but transitory.

Most prominent of this class are:

Ammonia	Ether
Alcohol	Camphor

Blood Pressure May Be Increased. 1. By stimulating the heart muscle, directly resulting in an increased tone, strength, and irritability. (Digitalis and strophanthus partly in this way.)

2. By constricting the blood vessels directly. It will readily be seen that if the force or number of beats remain constant, any constriction of the blood vessels will lead to an increase of pressure. (Adrenaline acts in this way.)

3. By constricting the blood vessels through a central nervous action (digitalis, strychnine).

4. By increasing the amount of fluid in the vessels, as in case of intravenous, hypodermic, or rectal injections of physiological salt solution.

The Number of Heart Beats May Be Increased By. 1. Excitement or peripheral stimulation (alcohol, ether).

2. Stimulation of the heart itself (caffeine).

3. Direct depression of the inhibitory nerves, either centrally or peripherally (belladonna).

4. Reduction of blood pressure and indirect depression of the inhibitory centers in the medulla (nitrites partly so).

5. Theoretically by stimulating the so-called accelerator mechanism of the heart.

INDICATIONS FOR CIRCULATORY STIMULANTS

These agents are indicated in heart failure and vasomotor paresis from various causes. In collapse, quickly-acting stimulants, such as ammonia, alcohol and camphor, are often effective, when their administration is combined with the external application of heat and the injection of physiological salt solution intravenously, subcutaneously or per rectum.

In shock (exhaustion of the vasomotor centers) the same measures would not prove of the same benefit as intravenous injections of adrenaline, which directly contracts the peripheral vessels, and in this manner increases the tone in the medulla.

Often circulatory stimulants with a constricting influence upon the peripheral arteries, as digitalis, are useful in valvular disease of the heart with simple dilatation, especially if dropsy is present. A certain amount of tension is necessary to equalize the two circulations, to keep the coronary arteries well filled and in this way supply the necessary nourishment for the organ, and to promote diuresis.

Drugs of the digitalis group act favorably in cases of cardiac incompetence, by diminishing the number of contractions and in this manner prolonging the diastole or period of rest for the organ. In heart weakness of asthenic fevers the digitalis group is less efficient than alcohol, strychnine or caffeine.

DIGITALIS

Synonym. Fox Glove

Parts Used. The leaves of *Digitalis purpurea,* collected from plants of the second year's growth. It is an ornamental flower of gardens, grows wild in Europe, Oregon and Australia, and is cultivated for the drug market in England and Germany.

Preparations and Doses.

Fluidextractum Digitalis. H. ♏ xv—lx. (1.—4.); D. ♏ ¼—iij (0.03—0.2).

Digitalis (leaves). The same dose as above in grains.

Tinctura Digitalis, 10 per cent. H. 3ij—viij (8.—30.); D. ♏ ij—xxx (0.13—2.).

Infusum Digitalis. H. ℥ij—vj (60.—180.); Dog. 3j—iv (4.—15.).

Toxic dose of the leaves. H. 3vj—viij (24.—30.); Dog. 3j—iv (4.—15.).

Active Constituents. The chief ingredients of digitalis are glucosides and it is therefore subject to early destruction. The following are the more important:

Digitoxin. Digitoxin most nearly represents the digitalis action. It is practically insoluble in water, but soluble in alcohol. It is present in the leaves to the extent of about 0.2–0.4 per cent.

Digitalin is the next of importance. It is slightly soluble in water, is soluble in 100 parts of diluted alcohol, and readily soluble in alcohol.

Digitalein. This is similar to digitalin. It is soluble in water and alcohol.

Under the influence of heat or acids, or when kept for some time in aqueous solutions, these glucosides tend to decompose and may form *toxiresins* which have a central convulsive action.

In addition to the above, digitalis contains *digitonin,* a saponin body, which foams with water and possesses the peculiar property of holding the otherwise insoluble active principles in solution in water. It is on this account that the aqueous infusion represents the activity of the drug. If administered intravenously, digitonin is the physiological antagonist to digitoxin, but it is not absorbed from the digestive tract.

Summary of Action. 1. A direct action upon cardiac muscle increasing its irritability and contractility, leading to a more powerful systole and finally lengthened diastole.

2. Vagus stimulation chiefly on account of increased blood supply but also partly direct.

3. Vasoconstriction by action both upon the arterial muscles and by central action.

4. Diuretic action in heart disease.

5. A local irritant action.

External and Local Action. There is no action upon the unbroken skin, but it is an irritant to the mucous membranes and subcutaneous tissues. When administered subcutaneously, it causes pain at the site of injection and through its irritant action may cause destruction of tissue with the formation of a slough or sterile abscess.

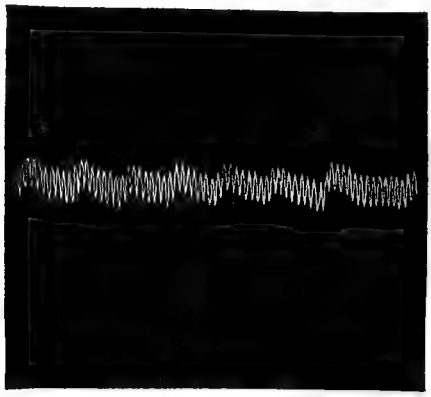

FIG. 6.—Normal blood-pressure tracing. The upstroke represents the heart systole, downstroke the commencement of diastole.

(Reproduced, by permission, from Pittenger's Biochemic Drug Assay Methods. Published by P. Blakiston's Sons and Co.)

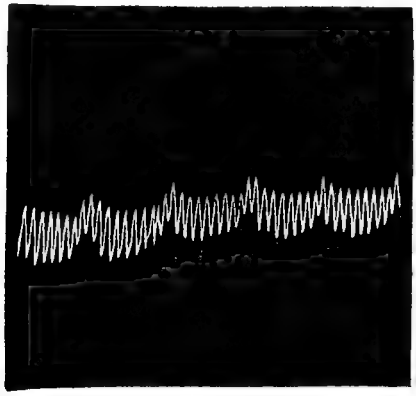

FIG. 7.—Action of digitalis, therapeutic stage. Note the increased length of upstroke (increased strength of contraction); also the increased space between the upstrokes (prolonged diastole).

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Consequently, hypodermic medication is to be avoided. Digitoxin is the most irritating and digitalein the least irritating of the glucosides.

Digestive System. Digitalis is a slight gastro-intestinal irritant, sometimes producing gastritis and diarrhea. On this account the drug is not well tolerated by certain animals. Emesis may

take place and be due either to direct irritation of the mucosa of the stomach or to a direct stimulation of the vomiting center after absorption to such an extent that small additional doses will cause emesis. This shows that it is time to stop its administration in order to avoid cumulative action.

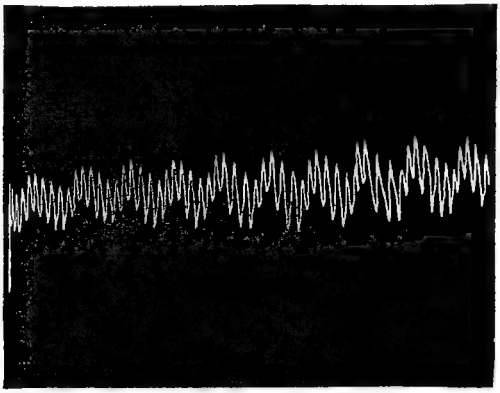

FIG. 8.—Action of digitalis. Combination of therapeutic stage with beginning of intermediate stage; characterized by slight irregularity and exaggerated inhibition. Note irregular length and increased space between strokes, showing irregularity of the heart's action preceding the toxic stage.

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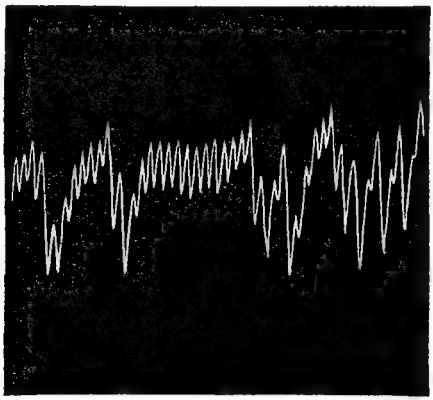

FIG. 9.—Action of Digitalis. Extreme inhibition and irregularity.

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It may cause diarrhea either by direct local irritant action upon the walls of the intestines or by stimulating the walls to increased peristalsis. It is therefore seen that whatever action is exerted upon the digestive tract is not desired.

Circulatory System. Here we get the principal action of the drug and may conveniently divide the action or effect into two stages, the therapeutic and toxic. Medicinal (therapeutic) doses of the drug slow the heart, increase its force and raise blood pressure. The diminished frequency of the pulse is due to stimulation of the vagus

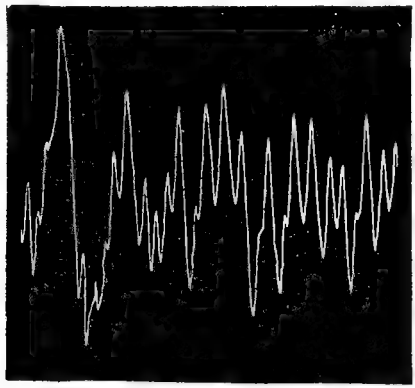

FIG. 10.—Action of digitalis. Marked toxic Action.
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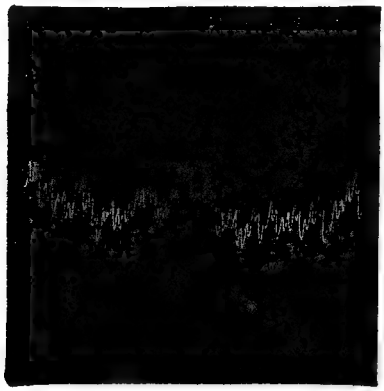

FIG. 11.—Action of digitalis: toxic stage. Delirum cordis preceding the death of the animal about 5 minutes. Note the weakness of the contractions and extreme irregularity.
(Reproduced, by permission, from Pittenger's Biochemic Drug Assay Methods. Published by P. Blakiston's Sons and Co.)

centers; the increased force of the heart beat is due to direct action upon the cardiac muscle, while the blood pressure is raised on account of the increased force of the heart, together with a constriction of the blood vessels. The constriction of the blood vessels is shown by the fact that blood pressure will rise before any effect is shown on the heart. The constriction of the arteries is due to direct action upon

their walls, and is seen principally in the splanchnic area, although it also occurs in the limbs. These results, however, are seen in the laboratory only after toxic doses and in therapeutic doses are very slight.

The sum of the above actions is an increased pressure in the aorta. This invigorates the coronary circulation, and the prolonged diastasis allows the heart to last longer. At the same time the increased systole favors emptying of the coronary veins. The result is an increase in supply of food and oxygen to the heart for nourishment and recuperation, and a greater supply of the drug to the heart muscle to maintain its stimulation.

Toxic Stage. The most prominent effect of this stage is irregularity of the heart, both in rhythm and force. In the first stages of poisoning the pulse becomes slow and irregular and the output less than before the drug was administered. In the second stage the pulse becomes rapid, but still more irregular. The final stage of poisoning shows a still greater increase in the number of beats until delirium cordis takes place and the organ stops in diastole.

Respiratory System. There is little or no action from therapeutic doses, although there may be some stimulation of the center on account of the improvement of the circulation. Toxic doses stimulate the center, so that the respirations may be strong and deep, but with the fall of blood pressure in the later stages the respiratory center fails.

Nervous System. There is no appreciable effect seen after therapeutic doses. Convulsions are usually seen in the later stages of poisoning. These are probably due to stimulation of the convulsive center in the medulla and partly to asphyxia which results from the poor circulation.

Diuretic Action. Digitalis has very little effect upon the flow of urine in normal animals. In heart disease, however, accompanied by effusion, it is a strong diuretic. The increased secretion of urine is entirely due to an increased blood pressure in the glomeruli of the kidneys. The water and chlorides of the urine are especially increased, while the other urinary constituents are but little altered.

Temperature. Large doses reduce temperature in febrile conditions. Toxic doses reduce it in normal animals.

Eye. Toxic doses cause a dimness of vision and mydriasis.

Absorption. Digitalis and its allies are slowly absorbed and eliminated. They are also slow in action, both on account of the tardy absorption and because their effect does not take place promptly, even after they reach the blood. Consequently immediate action cannot be obtained unless toxic doses are given intravenously, and even then, although an animal will pass through the different stages of action, death will not take place for several hours.

No appreciable effect will follow the administration of therapeutic doses for several hours, and the full effect only after it has been ad-

ministered for several days. On the other hand, the effects are very lasting, the heart remaining slow for several days after the drug has been discontinued, so that there is a tendency after repeated doses to an increased action or *cumulative* action. If this important fact is neglected and digitalis is pushed for more pronounced effect, the cumulative action may lead to the sudden development of the toxic stage of action. In this stage the heart is accelerated and may suggest the need of more digitalis, which, indeed, may temporarily slow the heart but will *always* hasten a fatal termination. A patient receiving digitalis should always be closely watched for a weak, irregular, rapid heart, and the drug withdrawn immediately.

Elimination. Digitalis is largely excreted by the kidneys.

Toxicology. The early symptoms of poisoning by digitalis are gastro-enteritis, irregular, full, slow pulse, followed in more serious or fatal cases by more pronounced symptoms of gastro-intestinal disorder, such as nausea, vomiting (in the dog and cat), diarrhea, irregular, rapid, weak pulse, cold extremities, salivation and finally death in from several hours to several days. There are no lesions except possibly some gastro-enteritis. The average toxic dose for the horse is 25 grams (about ʒvj); dog, 5 grams (about ʒj). According to Fröhner, death takes place whether these doses are given at one time or distributed over several days (3) in smaller amounts.

Treatment of poisoning. This should be mainly prophylactic or directed toward the avoidance of cumulative action. In the simplest conditions of poisoning where there is excessive vagus stimulation or irregularity of the heart, the treatment is to stop the drug, and keep the patient quiet until its effects have worn off. Atropine given subcutaneously will check the excessive vagus stimulation (causing slowing of the heart) but its effects will not last more than an hour. If there is reason to believe that some of the drug remains in the stomach, this should be evacuated by the stomach tube or an emetic, and tannic or gallic acid administered as an antidote. Aconite has been recommended as an antidote by some, while others say that it is not the physiological antidote. The rest of the treatment is purely symptomatic, as there is no specific for the treatment of poisoning by this drug. General stimulants may be given on account of the action on the medullary centers, but there is little that can be done to counteract its action upon the heart. The animal should be kept warm and quiet.

Action upon Different Animals. According to Fröhner, the crude drug or its preparations have no effect upon ruminants when given per os. Cows have stood without any reaction the fatal dose for the horse (30 grams daily for 4 days) for several successive days. It is therefore believed that the active principles are destroyed in the rumen since ruminants react the same as other animals if the drug is given intravenously. Horses are a little more susceptible than dogs.

Therapeutics. The principal use of digitalis is in the treatment of certain organic affections of the heart. Its use in veterinary medicine is therefore greatly lessened by the fact that horses so affected are not only useless for work but absolutely dangerous under the best of treatment, and animals are not usually kept unless there is reason to believe in a permanent cure. However, in functional disorders of the heart, the drug may prove of value although there is no doubt but that its use is overestimated. It is not a rapid acting drug, so should not be depended upon in emergency.

Its chief uses may be summed up as follows:

1. *Cardiac Tonic and Stimulant.* Digitalis is indicated in all diseases of the heart associated with debility or weakness of that organ, characterized by a rapid, weak pulse with low blood pressure (valvular disease, myocarditis, etc.), since it strengthens and regulates the heart, prolongs the beat, and procures a longer period of rest for that organ. Blood pressure is raised and consequently congestion and its sequellæ are relieved. Furthermore, there is increased circulation in the coronary arteries and consequently a better nutrition for the heart. In valvular disease it is especially useful since it causes compensation, prevents the reflux of blood, and relieves venous congestion. The indications depend not so much upon the location of the lesion as upon the stage of the disease. It is particularly useful in cases of diminished compensation in cardiac weakness with feeble pulse, while in cases of proper compensation it is not only useless but may be detrimental.

2. *Diuretic.* Digitalis is one of the most active and persistent diuretics in cardiac disease and therefore very useful in dropsies of cardiac origin. On the other hand, it is of very doubtful value in renal and hepatic dropsies and is of no value at all to remove exudates of an inflammatory nature (pleuritis, peritonitis arthritis or chronic hydrocephalus).

3. *Antipyretic.* Digitalis is inferior to acetanilid, antipyrin, etc., but single large doses may be of much service in infectious fevers accompanied by heart weakness, as in contagious pleuro-pneumonia of the horse. In such cases Fröhner recommends 10 grams (3ijss) for large horses and 5 to 7 grams (3 j¼–j¾) for small ones. These doses lower the temperature, slow and strengthen the heart, and usually improve the condition of the animal. These large doses are dangerous and should not be repeated.

4. *Pneumonia.* Digitalis is frequently indicated in pneumonia since it fills the arteries, relieves congestion, regulates the general circulation and increases the pulmonary circulation. It also fills the coronary arteries and increases the nutrition of that organ as mentioned previously. The use of the drug in pneumonia, however, must be entirely governed by the condition of the pulse. If the tension is low, the result of relaxation of the peripheral blood vessels

(vasomotor paralysis), it is recommended in full doses. If the tension is high, it is contraindicated and some vasodilator (nitroglycerin) should be substituted.

5. *As a Diagnostic Agent in Traumatic Pericarditis in Cattle.* Digitalin or digitalis injected intravenously often brings out obscure heart sounds, at the same time aggravating the symptoms, while in other diseased conditions of the heart the symptoms would be improved (Fröhner).

Administration. The drug should not usually be administered more than two or three times daily. If used in ordinary doses, and administered in this way, it will seldom produce disagreeable symptoms. If it is necessary to prescribe the drug for a long time it is better to skip three or four days every ten to twelve days.

The following prescriptions are representative of its use:

Horse, pneumonia.

℞ Digitalis ..... ʒ ijss
Althaeæ q. s.
M. Ft. Bolus.
Sig. Give at one dose.

For pneumonia in dog. Hyperemic stage.

℞ Tincturæ Nucis Vomicæ..... ♏ xxiv
Tincturæ Digitalis ..... ʒ j
Spiritus Ætheris Compositi..... ʒ ij
Liquoris Ammonii Acetatis..... ʒ iv
Aquæ q. s.....ad. ℥ iij
M. Ft. Solutio.
Sig. One, two, or three teaspoonfuls every 2 or 3 hours.

Cardiac dropsy, dog.

℞ Liquoris Potassii Acetatis..... 25.00
Infusi Digitalis 10.00
Extracti Juniperi 25.00
Syrupi Aurantii 90.00
M. Ft. Solutio.
Sig. Teaspoonful every 12 hours.

STROPHANTHUS

Synonym. Kombe Arrow Poison

Strophanthus is the ripe seeds of *Strophanthus kombe,* or of *Strophanthus hispidus,* deprived of their awn, woody climbing plants of Eastern Africa.

Active Constituent. Strophanthus contains a glucoside, strophanthin, which is either a single glucoside (methyl ouabain) or a mixture of glucosides. It is soluble in water and alcohol.

Preparations and Doses.

Powdered Seeds. Not used.

Tinctura Strophanthi. H. 3j—iv; 4, 15. D. ♏ ij—x; 0.13—0.6.

Strophanthin. H. gr. 1/5—1/2; 0.013—0.03. D. gr. 1/100—1/60; 0.0006—0.001.

Digestive Tract. The action is quite similar to that of digitalis, although some believe it to be a direct stimulant to intestinal muscle. Its active principle may serve as a bitter, but the drug is not used for this purpose.

Circulatory System. Strophanthus acts similarly to digitalis, except that in case of poisoning the heart may be arrested either in diastole or systole. The greatest difference between it and digitalis is seen in its action upon the blood vessels. Strophanthus, unlike digitalis, does not constrict the blood vessels. Consequently the slow rise in blood pressure is due entirely to its action upon the heart. This difference, however, is not seen in therapeutics.

Kidneys. It is absorbed and eliminated more rapidly than digitalis and is a more powerful diuretic. Cumulative action is said to be less apt to occur than in case of that drug.

Therapeutics. It may be used in the same conditions as digitalis but is less reliable than that drug and the margin of safety is not so great as in case of digitalis. It is also prone to cause diarrhea. Strophanthin or ouabain are better for intravenous or intramuscular use.

SCILLA — SQUILL

Synonym. Sea Onion

Parts Used. The fleshy inner scales of the bulbs of the white variety of *Urginea maritima* (Linne) cut into pieces and carefully dried.

Active Constituents. Squill contains scillitoxin, the most active principle, scillipicrin, acting upon the heart, scillin causing numbness, and a mucilage.

Preparations and Doses.

Fluidextractum Scillæ. H. 3j—ij; 4.—8. Dog. ♏ j—v; 0.06—0.3.

Tinctura Scillæ. H. 3iv—viij; 15.—30. Dog. ♏ v—xxx; 0.3—2.

Syrupus Scillæ. Horse. ℥ss; 15. Dog. 3ss—j; 2—4.

Syrupus Scillæ Compositus. Compound syrup of squill, contains squill, senega, and tartar emetic. Dose — same as the syrup.

Mistura Pectoralis, Stokes. Stokes' Pectoral Mixture N. F. contains 17.5 grams of ammonium carbonate, 35 mils of the fluid-

extract of senega, 35 mils of fluidextract of squill, 175 mils of paregoric, ammonia water, water and syrup of tolu to make 1000 mils. Dose — twice that of the syrup.

Physiological Action. Squill acts upon the heart much like digitalis. It is also a reliable diuretic acting by both an increased blood pressure in the kidneys and also by direct stimulation of the renal epithelium. It is a more powerful gastro-intestinal irritant than digitalis, often causing vomiting and purging even after moderate doses. On account of this action it was formerly used as an emetic. There is also some constituent eliminated by the bronchial mucous membrane on account of which it is a powerful and commonly employed expectorant.

Therapeutics. On account of its irritating properties, squill is not often prescribed alone but combined with digitalis, or calomel and digitalis when the latter drug is administered for heart disease or as a diuretic. It is a good expectorant and is especially indicated in chronic bronchitis of dogs, usually combined with other drugs as in either of the above syrups or as Stokes' Pectoral Mixture.

Chronic bronchitis, dog.

℞ Syrupi Scillæ ..... ℥ vj
Vini Ipecacuanhæ ..... ℥ ss
Syrupi Tolutani ..... ℥ vj
Mucilaginis Acaciæ ..... ℥ iv
Aquæ q. s. .....ad. ℥ vj
M. Ft. Solutio.
Sig. 1, 2 or 3 teaspoonfuls three times daily.

Other Members of the Group. The other members of this group are convallaria (or lilies of the valley), adonis vernalis, apocynum and euonymous (Wahoo).

Convallaria is the dried roots and rhizomes of Convallaria majalis, the common lily of the valley. It contains the active glucoside convallamarin and a saponin-like glucoside of the digitonin type, convallarin.

Apocynum (Canadian hemp or dog bane) contains the glucosides apocynin and apocynein. It is said to produce a digitalis-like action on the circulatory system and is a diuretic. It has been recommended as a substitute for digitalis but is a gastro-intestinal irritant in large doses and at the same time less reliable than digitalis.

Adonis Vernalis is not official. It contains a glucoside, adonidin.

Euonymous resembles the action of digitalis upon the heart but its other action (purgative) predominates so strongly that it is never prescribed for action upon the circulatory system.

DIGITALIS PRINCIPLES

On account of certain disadvantages of all drugs of the digitalis group, many investigators have endeavored to isolate the active principles of digitalis, yet its chemistry is not fully understood. Several principles have been isolated in a more or less degree of purity. Of the numerous ones obtained, digitalin and digitoxin together resemble quite closely the activity of the crude drug. The different brands of digitalin of commerce, however, are not true digitalin, but mixtures of two or more principles.

Digitaleinum Crudum. Crude digitalein is a mixture of glucosides prepared according to the method of Schmiedeberg, containing digitoxin, digitalin and digitalein. Its actions and uses are the same as those of digitalis.

Doses.

Horses and Cattle. ¼ to ½ grain (0.016—0.032). Dog. 1/60—1/20 grain (0.001—0.002).

Digitalinum Verum Kiliani. Digitalin true is also known as Schmiedeberg's Digitalin. It is a glucoside found in the leaves of *Digitalis purpurea* and derived commercially from *Digitalinum Germanicum.* Its actions and uses are the same as those of digitalis.

Doses.

Horse. ⅛—¼ grain (0.008—0.03 Dog. 1/30—1/10 grain (0.002—0.006) several times daily.

Digitalinum, French. Homolle's Digitalin — Digitalin Amorphe — is a mixture of glucosides obtained from Digitalis purpurea after the method of Homolle, consisting mainly of digitalinum verum Kiliani. Its actions and uses are the same as those of digitalis.

Doses.

Horses and Cattle. ⅛—¼ grain (0.008—0.015). Dog. 1/100—1/60 grain (0.0006—0.001).

Digitalinum Germanicum. Digitalin, German. This is a mixture of glucosides obtained from the seeds of digitalis by the method of Walz, consisting largely of digitonin, with digitalin verum and other active principles. This is the digitalin usually dispensed when digitalin is prescribed. It is variable in composition according to the method by which it is prepared.

Doses.

Horses and Cattle. ¼—½ grain. (0.016—0.033). Dogs. 1/60—1/30 grain (0.001—0.002).

Nativelle's Crystalline Digitalin is practically identical with digitoxin.

Digitoxinum. Digitoxin is the chief active principle of digitalis. Its action is very similar to that of the crude drug. Its cardiac action is very persistent, and when the therapeutic effects have passed off, a smaller amount will usually bring about the desired effects than was needed at first. It is very irritant and should not be used for subcutaneous or intramuscular injection.

Doses.

Horses and Cattle. ⅛—¼ grain (0.008—0.015). Dog. 1/100—1/60 grain (0.0006—0.001).

Ouabain, Crystallized is a glucoside obtained from *Aconcanthera ouabaio* by Arnaud, but also commonly obtained from *Strophanthus gratus.* It is also known as *crystalline gratus strophanthin.* It is a stable glucoside of great activity. The toxic dose is the same as that of digitoxin. It has been recommended as a physiologic comparison for digitalis on account of its stability.

PROPRIETARY PREPARATIONS

Digalen is claimed to be a sterile solution of soluble digitoxin (Clœtta) containing 1/225 grain (0.3 mg.) of digitoxin in each 15 minims (1 mil), the solvent being alcohol, glycerin and water. It is moderately irritating but may be used hypodermically.

Doses.

Horses and Cattle. 4 drams (15 mils). Dog. 5 to 15 minims (0.3—1.0) intramuscularly.

Digalen, Veterinary is marketed in tubes of four tablets, each containing 1.125 grams of Fol. Digitalis Titr. It has been especially recommended in the treatment of azoturia of horses.

Digitpuratum. According to Gottlieb's formula, this is an extract freed from digitonin and most of the extractive matter and is said to contain digitoxin and digitalin tannates. These are standardized and mixed with some inert material so that the dose is the same as for digitalis. It has been found to be a reliable preparation and may be obtained in tablet form.

Digipoten is a preparation very similar to digipuratum.

CAMPHORA — CAMPHOR

Camphor is a stearopten derived from the twigs and wood of Cinnamomum Camphora or made synthetically. It occurs as translucent white gummy masses, soluble in all the usual solvents except water, in which it is only slightly soluble, (8—1000 parts). It may be powdered by adding a few drops of alcohol or chloroform to it before rubbing in a mortar. When triturated with phenol, thymol,

menthol, or chloral hydrate, the mass becomes a liquid without undergoing any chemical change.

Preparation and Doses.

Camphor. H. ʒj—iiij; 4—15. D. grs. v—xxx; 0.3—2.
Spiritus Camphoræ. H. ℥jss—iv; 30—120. D. ♏ x—ʒiv; 0.6—16.
Aqua Camphoræ. Seldom used in veterinary medicine.
Linimentum Camphoræ (20% in cottonseed oil), externally.
**Ceratum Camphoræ* (Camphor ice), externally.

It also enters into combinations with many liniments, diarrhea mixtures, etc.

Action. Externally and locally. Camphor is a mild antiseptic and insecticide. When rubbed into the skin or kept in contact with the skin and evaporation prevented, camphor is an irritant, dilating the blood vessels and making the part red and warm. On the other hand, when applied in an alcoholic solution and allowed to evaporate, it is a refrigerant and blanches the part. Camphor is irritant to mucous membranes and causes them to contract. It is also irritant to the subcutaneous tissues.

Digestive System. When taken by the mouth, it produces a hot, burning taste and in strong solution causes a feeling of warmth to the stomach and is carminative. In excessive doses it is irritant to the stomach.

Circulatory System. *Before absorption.* When taken in strong solution, there is a short reflex acceleration of the heart. *After absorption.* The action of camphor after absorption is in considerable controversy. It is generally believed that there is a mild stimulation of the vagus and vasoconstrictor center and of the heart muscle. In normal animals, small doses cause very little if any change in the rate or force of the heart and the output of the heart is little, if any, increased. The action on the vasoconstrictor center is not constant, as the stimulation may not be seen or may be intermittent, so that there may be periods of increased blood pressure alternating with periods of lowered blood pressure. There is some dilatation of the cutaneous vessels, but not sufficient to affect the blood pressure. According to Cushny, "The heart of man and other mammals is sometimes slowed, but is generally little affected in either strength or rate." This action is generally agreed upon by other investigators, but some of them claim that in conditions of circulatory failure due to lack of production of normal stimulus in the heart (Fibrillation), camphor may be considered as a circulatory stimulant.

In Germany, camphor is used to revive the circulation in dying patients in which the automatic centers of the heart are believed to

* Unofficial.

be failing. Camphor stimulates the centers in the medulla, which may account for its beneficial effect upon the circulatory system; that is, through stimulation of the vagus and vasomotor centers.

Nervous System. Camphor stimulates the brain, medulla and spinal cord. The stimulation of the brain is shown by increased movements, excitement and delirium. After large doses, these symptoms are followed by unconsciousness and convulsions. The convulsions have been attributed to stimulation of the medulla, but there is evidence to show that they are partly, at least, of cerebral origin. All the medullary centers are stimulated. Large doses paralyze the medulla and cause death by collapse. The spinal cord is first stimulated, then depressed, but this action comes on late and is unimportant.

Temperature. Camphor is a mild antipyretic. It dilates the vessels of the skin and causes sweating. It also tends to relieve internal congestion, so is useful in colds.

Genito-Urinary Tract. By some authorities camphor is said to be an aphrodisiac but this is disputed by others.

Secretions. All secretions are slightly increased, but not sufficiently so to make camphor useful for this action.

Absorption and Elimination. Camphor is absorbed from the stomach, intestines and tissues and is chiefly eliminated by the urine, although some escapes in the sweat, feces and bronchial secretion.

Therapeutics.

1. *Externally.* Camphor is much used as a rubifacient liniment for sprains, bruises, mastitis, rheumatism, etc. In the form of Anderson's powder it may be used as an antipruritic in eczema, urticaria, etc. Combined with alum, boric acid, etc., it is useful as an antiseptic dusting powder.

Fröhner's Camphor bandage in lymphangitis, etc., is applied as follows: First a layer of cotton is applied to the leg from the coronet to the stifle. This is covered with gauze saturated with spirits of camphor, this is then covered with some impervious material and the whole is held in place with a common bandage. At frequent intervals, as often as is necessary, inject spirits of camphor beneath the bandage.

Camphor and phenol, in the proportion of one part of phenol to three of camphor, are useful in burns, abrasions and small wounds.

For its stimulant action upon mucous membranes, camphor may be added to sprays or washes used in respiratory diseases. It may also be servicable in acute coryza by inhalation. Thus, a teaspoonful of powdered camphor is added to a cup of hot water and the steam inhaled.

Internally:

1. Antispasmodic — In thumps, spasmodic colic, etc.

2. Carminative — In tympanites, colic, diarrhea, etc.

3. Circulatory and respiratory stimulant, in conditions of threatened heart failure, as in septicemia, pneumonia, collapse or shock.

4. In adynamic fevers camphor may serve as a useful antipyretic and reflex circulatory stimulant. It may be useful in sudden depression coming on in the course of acute or prolonged diseases.

5. In chronic nasal catarrh or cold in the head, camphor will be found useful when inhaled or given for internal medication.

Administration. For external application, camphor may be applied as the spirits, as Fröhner's bandage, or in combination with oils or other substances in the form of liniments.

Internally it may be given as the powdered drug in capsule, or as the tincture in solution or capsule. As a rapid circulatory stimulant it is best given in solution in olive oil (20 per cent.). It should be given intramuscularly, not subcutaneously on account of liability of abscess formation if given by the latter method.

Anderson's Antipruritic Dusting Powder.

℞ Camphoræ ..... ʒ j–ij
Amyli.
Zinci Oxidi .....āā ʒ ss
M. Ft. Pulver.

Antipruritic Ointment.

℞ Camphoræ.
Phenolis āā ..... gr. v
Ung. Zinci Oxidi q. s. .....ad. ℥ j
M. Ft. Unguentum.
Sig. Apply as directed.

Mastitis.

℞ Camphoræ ..... ʒ iv 5.
Adipis ..... ℥ iv 50.
M. Ft. Unguentum.
Sig. Apply to udder. *Bang.*

Intramuscular Injection.

℞ Camphoræ ..... 20.
Olei Olivæ q. s. .....ad. 100.
M. Ft. Sol.
Sig. Horse and cow one-half to one ounce; dog one-half to one dram at two-hour intervals.

Antiseptic Dusting Powder.

℞ Phenolis.
Camphoræ .....āā ʒ j
Aluminis Exsiccati.
Zinci Oxidi .....āā ʒ ij
Acidi Borici q. s. .....ad. ℥ viij
M. Ft. Pulver.

Coryza of Dog.

℞ Camphoræ ..... gr. xij
Extracti Opii ..... gr. iij
Ammonii Carbonatis ..... gr. xxiv
M. Fiant Capsulæ No. 12.
Sig. One every two hours.

CAMPHORA MONOBROMATA

Monobromated camphor is obtained by the union of camphor with bromine in the presence of heat. It occurs as colorless prismatic crystals, needles or scales; it has a mild camphoraceous odor and taste; slightly soluble in water and glycerin, freely soluble in alcohol, ether and chloroform. *Doses.* D. grs. ij—x; 0.13—0.6.

Monobromated camphor in small doses is sedative to the nervous system. It has been recommended as an antispasmodic and anaphrodisiac in man and the small animals, but its results are somewhat questionable.

Borneol Camphor. This resembles the action of camphor in many respects, but does not stimulate the heart and finally depresses the nervous system. It has no therapeutic indications in veterinary medicine.

OTHER CIRCULATORY STIMULANTS

Ether. This drug ordinarily has little influence upon the heart, but through its local irritant action may reflexly increase the pulse and slightly raise blood pressure. It may be given subcutaneously in doses about one-half of the oral ones, and is useful in sudden heart failure, as in shock, poisoning or collapse.

Adrenaline. If this is given intravenously in therapeutic doses the pulse is slowed and blood pressure raised. The slowing of the pulse is due to stimulation of the cardio-inhibitory center in the medulla, while blood pressure is raised by direct constriction of the peripheral vessels, together with its direct stimulating action upon the heart. These actions take place promptly but are of short duration. Sometimes a solution of adrenaline 1—50,000 in normal salt solution is used intravenously in cases of shock resulting from injury or operation. See page 98.

Nitrites. To this group belong nitroglycerin, amyl nitrite, and sodium nitrite. All act similarly but differ in rapidity and persistence of action. Amyl nitrite is most rapid and least persistent, while sodium nitrite is least active and most persistent. All the nitrites accelerate the heart, probably by action upon the vagus center, and lower blood pressure by depressing the muscles of the arteries, causing vasodilation. Their chief value does not depend upon any direct action upon the heart but on the fact that they dilate the peripheral vessels and consequently lessen the work of that organ by

diminishing the resistance in the blood vessels. The general indications will be mentioned later. Page 105.

Strychnine. This drug raises blood pressure by stimulating the vasomotor center. This action combined with its influence upon respiration, digestion and muscle tone make it a valuable remedy in circulatory shock. In simple dilatation of the heart it can be advantageously combined with digitalis. It may prove of more value in pneumonia and other infectious diseases than digitalis. It is also indicated in chronic bronchitis and emphysema to support the respirations as well as the circulation. Page 129.

Barium. Barium chloride in small doses stimulates the heart muscle and makes the heart beat stronger but more slowly. It therefore has a digitalis like action but is not used in therapeutics for that purpose.

Ammonium Compounds. Ammonia water, carbonate of ammonium or the aromatic spirits of ammonia are quickly acting diffusible stimulants in cardiac or respiratory failure. They may be given per os and produce their action almost immediately, probably through a reflex action by irritation of the stomach. They may also be given by inhalation, in which case the action is due to irritation of the fifth cranial nerve or in extreme cases may be given subcutaneously or intravenously. Cushny says that in this case "the local action may be reinforced by a direct action on the medulla oblongata." The action is very transitory but may be sufficient to tide the patient over a period of collapse.

Alcohol. Strong alcoholic solutions are reflex circulatory stimulants through irritation of the stomach. Their action is of but short duration.

Cactus Grandiflorus. There are several species of cactus with more or less medicinal power, but the one mentioned above is believed to be the most active so far as the circulatory system is concerned. While some investigators claim that it is a distinct circulatory stimulant, others assert that it has very little action. At best it must be considered very much in doubt. *Cactoid Abbott.* H. Gr. $\frac{1}{12}$. D. Gr. $\frac{1}{60}$.

Liquor Hypophysis. Solution of pituitary body has an action similar to that of adrenaline. It is discussed more fully under the vasoconstrictors.

2. CIRCULATORY DEPRESSANTS

Circulatory depressants are agents that lessen the efficiency of the heart and lower blood pressure. They may also be defined as those agents which lessen the activity of the heart. They diminish the output of the heart per unit of time and may produce this action by:

1. Directly depressing the cardiac muscle (chloral hydrate, chloroform and potassium salts).

2. Stimulating the inhibitory mechanism of the heart. The vagus mechanism may be stimulated directly (digitalis, aconite, veratrum), or indirectly by stimulating the vagus center through an increase of blood pressure (adrenaline).

Blood pressure may be lowered by:

1. Decreasing the output of the heart per unit of time (cardiac depressants and vagal stimulants).

2. Decreasing the amount of fluid in the veins (venesection).

3. Decreasing the resistance in the peripheral vessels (vaso dilators and purgatives).

A large majority of drugs, in large doses, depress or weaken the heart by direct action upon the cardiac muscle, but only those acting through the vagus mechanism are of any therapeutic value for this purpose. Drugs acting upon this mechanism slow the heart and in this manner lower blood pressure, so that they are particularly serviceable in cases of rapid heart with high tension, as in the asthenic (mild) fevers, in the early stages of sthenic or long fevers, in acute local inflammations, in valvular disease with excessive hypertrophy, as in aneurism with high tension. In cases of rapid pulse with low tension, drugs of the digitalis group are to be preferred.

ACONITUM — ACONITE

Synonyms. Wolfsbane, Monkshood

Parts Used. The dried tuberous roots of *Aconitum napellus,* and yielding, when assayed, not less than 0.5 per cent. of the ether soluble alkaloids of aconite.

Constituents. Aconite contains an alkaloid, aconitine, to which its action is due together with aconine in minute amounts, which is said to be a cardiac stimulant, benzoaconine, picroaconine and aconitic acid, which are inert. Aconitine is a crystalline alkaloid, slightly soluble in water, but freely so in dilute acids or alcohol. The amorphous aconitine of commerce is a mixture of alkaloids of variable strength but much weaker than the crystalline variety. Aconitine is the most toxic alkaloid known.

Preparations and Doses.

Fluidextractum Aconiti. H. ♏ v—xv; 0.13—0.3. D. ♏ 1/10—1; 0.006—0.06.

Tinctura Aconiti. H. ♏ x—xxx; 0.6—2. D. ♏ 1/2—2; 0.03—0.13.

Flemmings Tincture. H. ♏ v—xv; 0.13—1. D. ♏ 1/4—1; 0.0016—0.06.

Aconitine U. S. P. Crystalline. H. gr. 1/30—1/5; 0.002—0.012. D. gr. 1/600—1/250; 0.00011—0.00025.

Summary of Action. 1. Stimulation followed by paralysis of many different nerve endings, sensory, motor, and secretory.

2. Stimulation followed by depression of certain parts of the central nervous system.

External Action. If applied to the skin in aqueous solution there is little if any action, because it is not absorbed, but if mixed with alcohol, or some other absorbable material, it stimulates, then depresses the sensory nerve endings, producing a tingling, tickling or a burning sensation, followed by numbness or anesthesia. This same effect is seen if the drug is taken internally in large doses. The above action, however, is not accompanied by any signs of inflammation, so that aconite is not a protoplasmic poison and must be considered as having a selective action.

Digestive System. Here we have the same action as described under the head of external action together with salivation when the drug is taken in the mouth. Large doses cause considerable irritation to the mouth and stomach, but as in case of its external action there are no signs of inflammation. There is also a sense of constriction of the fauces and anesthesia to taste. Medicinal doses may serve as sedatives to the stomach, increasing the secretions, while large doses may cause pain, nausea and vomiting.

Circulatory System. The action upon the heart is due to vagus and accelerator stimulation and to direct action upon the heart itself. After a very brief period of activity from accelerator stimulation, which is unimportant, aconite slows the heart by vagus stimulation and lowers blood pressure. Since there is no increased strength of contraction with the slowing, less blood is forced through the heart per unit of time, and pressure falls. In *toxic doses,* however, aconite has a direct stimulating action upon the heart muscle, increasing its irritability and causing it to become more rapid, weak and irregular. As the action becomes more intense, the irregularity increases until delirium cordis suddenly takes place. The arterioles may be constricted for a short time on account of stimulation of the vasomotor center, but the lessened force of the heart brings about a marked though variable reduction in blood pressure.

In therapeutics it has been assumed that aconite would produce pure vagus stimulation with slowing of the rate of the heart and fall in blood pressure, but Mackenzie, in 1911, gave large doses of the tincture frequently to men and in many cases obtained no action. Price pushed the drug in fibrillation of the auricles where digitalis was effective, and in rapid heart due to fevers and other causes, but without any evidence of a reaction upon the heart or blood vessels. Rudolf and Cole (1913) in a test of 55 human patients with and without fever failed to get any change in the pulse rate.

From therapeutic doses there is no depression of the vasoconstrictor mechanism, and the drug lowers pressure, if at all, by pure cardiac depression and not by dilatation of the arteries.

Nervous System. Aconite stimulates the respiratory center, but this shows a strong tendency to become depressed and death frequently results from paralysis of this center. In fact, this tendency is so great that aconite cannot be used as a respiratory stimulant in therapeutics. The respirations are slowed under moderate doses. They are strongly affected with large doses, becoming shallow, slow and labored, and the animal suffers from dyspnea. The accessory muscles of respiration contract vigorously. In fatal cases, convulsions interrupt the breathing and, between the convulsions, the respirations are weaker and finally stop. The above depressing effects are due to depression of the respiratory center.

Secretions. The saliva is increased partly reflexly and partly through stimulation of the nerve endings. The sweat is increased, probably by stimulation of the nerve endings in the glands and perhaps by slightly dilating the skin vessels but, at best, it is a poor diaphoretic.

Absorption and Elimination. Aconite is rapidly absorbed from the mucous membranes and fairly so through the skin from alcoholic or oily solutions. It is probably largely eliminated through the kidneys and skin and some authorities attribute marked diaphoretic properties to it.

Temperature. Aconite is believed to lower temperature, both in health and febrile conditions, but is not strongly antipyretic. The reduction in temperature is probably due to slowing of the circulation and in this way diminishing metabolism to its depressant action upon all muscular tissue, and to some extent to dilatation of the vessels of the skin, increasing radiation.

Toxicology. Aconite usually produces death by asphyxia brought about by paralysis or depression of the respiratory center, although a single large dose may kill by syncope due to sudden paralysis of the heart.

In the horse the usual symptoms of poisoning by aconite are salivation, champing of the jaws, frequent attempts at swallowing, rapid, weak, almost imperceptible pulse, regurgitation of air and fluid from the nostrils, cold, clammy sweat, irregular, labored respirations, muscular weakness and in the later stages, paralysis of the extremities, especially the posterior. In some cases, there are colicky pains, nausea and diarrhea.

Cattle are said to be less susceptible and able to stand relatively larger doses than horses. Dogs are quite susceptible to the drug. One dram of Flemming's Tincture has killed a dog in thirty minutes with the following symptoms: Salivation, retching, vomiting, muscular weakness, weak rapid heart and paralysis of the posterior extremities. The pupils are dilated and convulsions usually occur.

The treatment is first to keep the animal warm and quiet. Then evacuate the stomach and treat the symptoms. Belladonna is said

to be antidotal because it not only checks the vagus activity but also stimulates the respiratory center and depresses the constrictor endings in the bronchial muscles, thus overcoming the difficult respiration. Diffusible stimulants (ether, alcohol, etc.) are always indicated. Artificial respiration should be resorted to if necessary.

Therapeutics.

Internally. According to the results of recent investigations, aconite has doubtful therapeutic value when taken internally. It has been used to reduce the force and frequency of the pulse, cause arterial relaxation and equalize the circulation, in other words, to allow the blood to flow from a congested part. Thus, it has been especially recommended in the first stages of acute febrile conditions of the young, and in those of short duration, as in coryza, laryngitis, distemper, etc., or in the first stages of sthenic fevers but not in the latter course of the fever. It has also been recommended in the first stages of inflammatory diseases, such as rheumatism, lymphangitis, laminitis and mastitis, but is not indicated in long continued fevers. In any case, however, the selection of the drug should depend upon the condition of the pulse. If it is of low tension, probably digitalis is to be preferred, while if the tension is high, aconite might be useful.

Externally. Aconite is useful as an ointment or liniment, to relieve pain of an inflammatory nature, as in rheumatism, sprains, etc.

Preparations and Administration. On account of the extreme toxic action of aconitine, the tincture is commonly used. Any preparation should be given frequently in small doses, at intervals of an hour or less, until the desired action is procured. Then the doses should be diminished or the intervals increased to maintain the desired action. Aconitine is dangerous to use both on account of its extreme toxic action and because preparations of it vary greatly. The amorphous aconitine is much weaker than the crystalline and a change from it to the crystalline is very liable to result in death, provided the dose has been the same.

℞ Fluidextracti Aconiti 40.0
Linimenti Chloroformi 60.0
M. Ft. Linimentum.
Sig. Apply as directed.

Delphinum (larkspur) and staphisagria (stavesacre) are botanically and pharmacologically related to aconite, but their use is limited to the destruction of lice, as,

℞ Tincturæ Delphini.
Etheris āā. q. s.
M.
Sig. Apply as directed.

VERATRUM VIRIDUM

Synonym. Hellabore.

Parts Used. The dried roots and rhizomes of *Veratrum Viridi,* green hellabore. There is also a Veratrum album, white or European hellabore. The U. S. P. of 1905 included both varieties under the name of Veratrum, but the European variety was dropped in the last revision.

Constituents. Veratrum contains several alkaloids of which the following are the most important: veratrine, jervine, pseudojervine, rubijervine and cevadine. Veratrine, U. S. P., is an entirely different preparation, being a mixture of alkaloids obtained from a closely related plant of Mexico, the *Cevadilla* or *Asagræa officialis.*

Preparations and Doses.

Veratrum Viridum. H. and C. 3ss—j; 2.—4. D. gr. j—ij; 0.065—0.13.

Tinctura Veratri Viridi. H. and C. 3v—℥jss; 20—45. D. ♏ ij—xv; 0.13—1.0.

Fluidextractum Veratri. Same as of the powdered drug.

Action. Veratrum closely resembles aconite in most of its actions. It is a stronger irritant externally and locally, exciting considerable irritation when applied locally, and causing sneezing when brought in contact with the nasal mucous membranes. Internally it resembles the action of aconite with the following exceptions: (1) It is more irritant and liable to cause nausea and vomiting. (2) It is a stronger depressant to muscles, probably on account of its nauseant action. (3) It is a more powerful depressant to the circulatory system. Small doses reduce the force of the heart and to a certain extent its rate, while moderate doses distinctly lessen the rate on account of stimulation of the vagus mechanism. (5) The respirations are not so depressed as with aconite, and, (6) It is rapidly absorbed and mainly eliminated by the bowels.

Toxicology. The symptoms resemble those caused by aconite, but there may be more nausea and less anesthesia. The treatment is the same as for aconite poisoning.

Therapeutics. The general therapeutics of veratrum are very similar to those of aconite. It has no advantage over that drug for action upon the circulatory system. It may be used as an emetic in swine on account of its irritant and nauseant properties. The powdered root may be of some value as a parasiticide for lice, fleas, etc., although it must be used cautiously.

VERATRINE U. S. P.

As mentioned previously, veratrine is a mixture of alkaloids, but is especially rich in cevadine to which its action is due.

Doses.

Horses and Cattle. gr. ss—ij; 0.03—0.13. Pigs. gr. ¼—½; 0.0015—0.03. Dogs. gr. 1/32—1/16; g. 0.002—0.004.

**Oleatum Veratri.* 2 per cent., for external use only.

**Unguentum Veratri.* 4 per cent., for external use only.

Action. Veratrine is very irritant to the skin, mucous membranes and raw surfaces, and in large doses to the digestive tract. On account of its irritant action it causes sneezing and coughing when brought into contact with the respiratory mucous membranes. Moderate therapeutic doses given hypodermically often cause disagreeable symptoms, such as uneasiness, perspiration, colicky pains, increased peristalsis, passage of urine and feces, muscular trembling and weakness. These symptoms should be kept in mind because they may be caused by therapeutic doses.

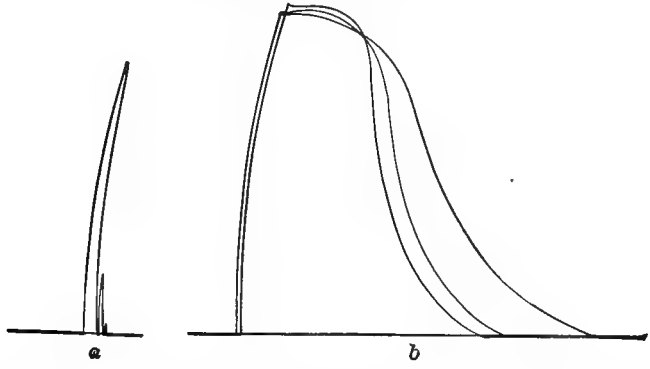

FIG. 12.—Tracings of muscular contractions from gastrocnemius of the frog. *a*, normal; *b*, three successive contractions taken at one minute intervals, five minutes after the injection of veratrine.

(Reproduced, by permission, from Cushny, Pharmacology and Therapeutics. Published by Lea and Febiger.)

Muscles. Veratrine has a specific action upon all striated muscle. Fatigued muscles are said to regain their activity more quickly under the influence of veratrine and the heart to beat four times as strongly (Fröhner). Its action upon striated muscle is peculiar in that a muscle under the influence of veratrine will respond to stimuli and contract as rapidly as normal muscle but the period of relaxation is much prolonged.

* Unofficial.

Cardiac Muscle. The action upon the heart corresponds exactly with its action on other striated muscle, consisting of a rapid contraction and prolonged relaxation.

Circulatory System. In general veratrine closely resembles aconite. Therapeutic doses slow the heart through central vagus stimulation. Blood pressure falls on account of slowing of the heart, although there may be some vasomotor stimulation. Large doses paralyze the vagus mechanism, so that the heart is quickened, but blood pressure does not rise because the vasomotor center is so depressed. Toxic doses accelerate the heart and cause it to become irregular through paralysis of the heart muscle, vagus endings and vasomotor center.

In poisoning, consciousness remains for a long time. Three grains (0.2 gm.) produced toxic symptoms in a horse with symptoms of gastroenteritis, excitement, uneasiness, muscular contractions, convulsions and paralysis. Horses have been killed by doses of from 7½ to 15 grains (0.5—1.), although there seems to be some idiosyncrasy in regard to the drug and some difference in the various preparations. Two young horses were killed by doses of 1½ grains (0.1 gm.) in sixteen and twenty hours respectively, yet these must be considered as ordinary therapeutic doses for the horse. On the other hand, 6 grains (0.4 gm.) have been administered without alarming symptoms (Fröhner).

Therapeutics. Veratrine is not used to a very large extent in this country. In Germany it is recommended for the following:

1. For the same general class of symptoms for which aconite is indicated.

2 As an emetic for swine: ¼—½ gr. (0.02—0.04 gm.) hypodermically in 2 to 4 mils of alcohol. Dogs would require gr. 1/32—1/16 (0.002—0.004 gm.) but other agents are to be preferred.

3. As a stomachic and ruminatorium for various forms of indigestion in ruminants. It is also frequently employed as an emetic for ruminants, in overloaded or impacted rumen.

4. As a nerve stimulant in paralysis of the muscles from various causes, but the indications for it are probably largely overrated.

5. As an antirheumatic in chronic rheumatism, shoulder and hip lameness of the horse. In this instance it is injected in the region of the diseased muscle, starting with very small doses and gradually increasing them daily.

Arecovetrol consists of 8 capsules, four of which (A) contains 1½ grains of arecoline and nux vomica and four of which (B) contain 1½ grains of veratrine and nux vomica. This is recommended in indigestion in cattle and as a diagnostic agent in traumatic gastritis. *Dose:* Alternate a capsule of A with one of B every two to three hours; administer in a mucilaginous drink. Eight capsules constitute a treatment. (G. Halling, Lasdehen, Ostpr., Germany.)

3. VASOCONSTRICTORS

Vasoconstrictors are drugs which constrict the peripheral arterioles. They may act by:

1. Stimulating the vasomotor center (atropine, caffeine, strychnine).

2. Stimulating the muscles of the arterial walls directly (adrenaline).

3. Acting both centrally and peripherally (digitalis, ergot, cocaine).

Vasoconstrictors raise blood pressure, tend to lessen the number of the heart's beats by increasing the tonus in the medulla and stimulate respiration. They are indicated internally in conditions of low arterial tension, as collapse and shock.

Vasodilators act directly opposite to the constrictors. The most important members of this group are the nitrites and especially the organic nitrites (nitroglycerin, erythrol, etc.). These act peripherally and are indicated when it is desired to lower arterial pressure so as to facilitate the passage of blood through the vessels and in this way lessen the work of the heart.

EPINEPHRINA — EPINEPHRINE

Synonyms. Adrenaline, Suprarenaline, Superacapsuline.

This is an alkaloid obtained from the extract of the suprarenal glands of animals used as food for man. This preparation is sold under various trade names, adrenaline, supracapsuline, suprarenaline, etc., in a solution supposed to be of the strength of one part of adrenaline chloride to one thousand. This solution is not decomposed by a moment's boiling and consequently may be sterilized by heat, but prolonged boiling decomposes it. On long standing, or when diluted, it slowly deteriorates, changing to a pinkish color, and finally forms a precipitate. It should be discarded upon the appearance of a precipitate. There is a synthetic preparation, "suprarenin," of about half the strength of the above.

The dried glands are official as "Suprarenalum Siccum."

Preparations and Doses.

Solution of Adrenaline chloride 1—1000.

Subcutaneously. Horses and Cattle. ʒj—ij; 4—8. Dogs. ♏ iij—viij; 0.2—0.5.

Intravenously. Dilute with ten parts of physiological salt solution. Dose of the mixture: Horses and Cattle. ʒss—ij; 2—8. Dogs. ♏ ij—viij; 0.13—0.5.

In shock give intravenously in the proportion of 1—50,000 in physiological salt solution. The injection should be made slowly and as needed.

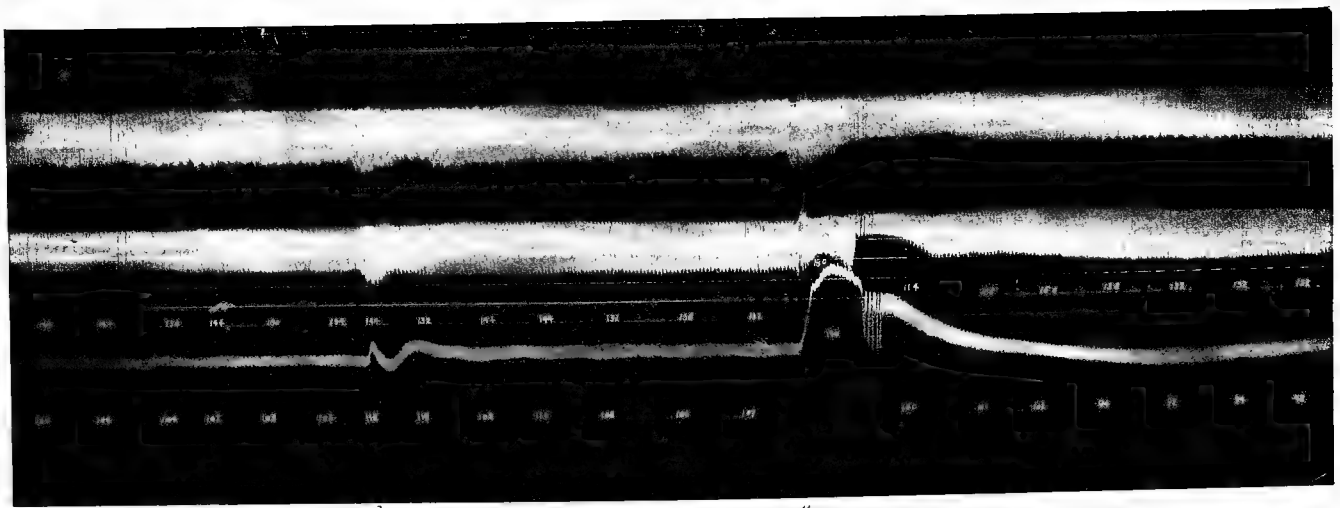

FIG. 13.—Adrenaline chloride solution. At *a*, 2 c.c. subcutaneously. No effect on blood-pressure. At *b*, 2 c.c. deep in thigh muscles. At *c*, 0.1 c.c. by vein; prompt rise in blood-pressure (lower tracing) from 107 to 190, loss of tone and contractility of the ventricle (middle tracing), and increase in contractility of the auricle (upper tracing). The down-stroke of auricle and ventricle is systole. Marked vagus effects are present. (Tracing made by Dr. C. C. Lieb.)

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Action. Externally and locally. There is no action upon the unbroken skin, but if it is applied to mucous membranes or raw surfaces, it penetrates sufficiently to stimulate the vasoconstrictor nerve endings of the arterioles at the site of application. This results in a local constriction of the arterioles, which is so marked that the blood is almost completely shut off, and as a consequence, the tissues shrink and become very pale and bloodless, so that any moderate hemorrhage is checked. This local vasoconstriction is greater than from any other drug known. This action is produced very quickly and lasts from ten to twenty minutes to two hours, but may be prolonged at will by repeated applications. Vasodilation follows vasoconstriction, so that when the drug is withdrawn or its effects wear off, the arterioles not only relax, but may go beyond their normal tone and there may be a return of the conditions for which it was applied, hemorrhage, etc. The cause of the vasodilation is in controversy.

Absorption. The drug is not absorbed rapidly enough from the mucous membranes or digestive tract to produce systemic effect, probably on account of the vasoconstriction of the parts with which it comes in contact.

Subcutaneous tissues. A slight rise of blood pressure often follows the hypodermic administration of adrenaline, but it is not constant and cannot be relied upon.

Intramuscular injection. Enough may be absorbed from deep muscular injections to cause a rise of blood pressure and relax the bronchioles.

Intravenous injection. When given in small doses intravenously, adrenaline greatly increases blood pressure and slows and strengthens the heart. The increased pressure is largely due to a direct constricting action upon the arterioles but also, to a lesser extent, to stimulation of the heart muscle. The pulse is slowed by direct action on the vagus center and also by an indirect action on this center through an increased blood supply. The vasoconstriction is largely peripheral, as can be seen from its local application to mucous membranes or after the central nervous system has been destroyed.

Respiratory System. Small doses of adrenaline administered hypodermically cause increased depth of the respirations, while larger doses quicken the respirations but render them shallow.

Muscles. The action of adrenaline varies somewhat upon plain muscle. Thus it has a constricting influence upon the ureter, vas deferens and seminal vesicles in the male, and the uterus and vagina in the female, while it retards movements of the stomach and bowels.

Glands. Certain glands are stimulated so that there is an increased secretion of saliva, tears, bile and bronchial mucus.

Duration of Action. The period of action of adrenaline is very short, lasting but a few minutes. There is no characteristic action

when administered per os, and little if any action unless given intravenously, yet clinical experience points to a fairly good absorption from the subcutaneous tissues. The effects of intravenous doses vary with the dose. The results of increasing doses according to Sollmann are:

1. Rise of blood pressure.
2. Inhibition of the bladder, mydriasis.
3. Constriction of the uterus, vas deferens, and seminal vesicles, salivation, lachrimation, inhibition of the gall bladder, increased bile secretion, stimulation or depression of the internal anal sphincter.
4. Contraction of the erectores pilorum.
5. Uncertain action upon the tunica dartos and sweat.

Therapeutics. 1. *Circulatory stimulant.* Since the characteristic action of the drug is produced only after intravenous administration, and even then its effects are very transient, it is not used to a large extent as a circulatory stimulant in veterinary medicine. It may be very useful in collapse and shock during anesthesia because in this condition there is usually a good heart muscle but marked vasodilation. For the best results, it should be given slowly as an infusion as mentioned under circulatory stimulants.

2. *Vasoconstrictor.* As a local vasoconstrictor its use is limited to the relief of congestion of mucous membranes and the control of hemorrhage in operations. It is frequently used in combination with some local anesthetic, in which case it not only prevents hemorrhage and makes the operation bloodless but also retards the absorption of the anesthetic and thus prolongs the anesthesia. It is said to be worthless in distant hemorrhages but clinical experience points in the other direction.

3. *Azoturia.* Adrenaline was at one time very highly recommended in the treatment of azoturia. It was used in dram doses subcutaneously in treating this disease.

4. *Laminitis.* Adrenaline is recommended by several practitioners in the treatment of founder. The drug is to be injected subcutaneously in the region of the plantar nerves of the affected limbs.

PITUITARY BODY. HYPOPHYSIS SICCA

Liquor Hypophysis. This is a solution of the water soluble principle or principles obtained from the fresh posterior lobe of the pituitary body of cattle. One company markets the preparation under the trade name "Pituitrin," although as yet no active principle has been isolated.

Doses. Horses and Cattle. ʒij—ijss; 8.0—10.0. Dogs. ♏viij—xvj; 0.5—1.0.

Action. The most prominent feature of the action of this drug

is its similarity to adrenaline, from which it differs mainly in being slightly slower and somewhat more persistent (2–3 times) in action. The effect of pituitrin, on the other hand, is brought about in a different way than that of adrenaline, in that its action upon the heart and blood vessels is due to direct action upon the muscles and not through the nerve endings.

Uterus. The plain muscle of the uterus is so stimulated by deep muscular or hypodermic injections that the drug has been recommended for use in uterine inertia.

Milk. Many investigators have experimented with pituitrin upon the secretion of milk. It is generally conceded that the injection of pituitary extract will increase, temporarily at least, the amount of milk and the per cent. of fat. Simpson and Hill, experimenting upon goats and cows, conclude as follows:

"*Goats.* The administration of pituitary extract, by intravenous, muscular or subcutaneous injection, to a lactating animal leads to an increase in the quantity of milk secreted and also in its fat content. In the goat, if the injection be continued at intervals over a prolonged period — several months — immunity to its action on the mammary gland appears to be established both in regard to the amount of milk yielded and the percentage of fat it contains.

"*Cow.* 1. In the cow, the intravenous injection of pituitary extract (whole glands or posterior lobe alone) leads to an immediate secretion of milk very rich in fat. The effect, however, quickly passes off.

"2. There is a corresponding diminution of milk at the next milking period, and to some extent in the percentage of fat, so that for the twenty-four hours, there is practically no increase either in the quantity of milk or of fat obtained."

Toxicology. Pituitary extract is comparatively nontoxic, according to Haughton, who gave a 500 gram guinea pig 15 mils per os. or 3 mils hypodermically without causing toxic symptoms.

Urine. Pituitary extract is a marked diuretic, producing its action by a local dilatation of the renal vessels and probably by stimulating the renal cells.

Therapeutics.

1. *Dystokia.* In dystokia due to uterine inertia, especially in dogs, cats and swine.

2. *Prevent hemorrhage.* According to Gorton, solution of the pituitary body increases the coagulability of the blood when given subcutaneously and greatly diminishes hemorrhage when administered a few minutes previous to operating upon the nose and throat.

3. *Shock.* Hypodermic injections of the solution may be useful in shock from anesthesia or operations.

METHODS OF INCREASING THE VOLUME OF BLOOD IN THE ARTERIES

The principal methods of increasing the volume of blood in the arteries are:

1. Transfusion of blood.
2. Administration of saline solution by intravenous infusion, hypodermoclysis or rectal injection.

Transfusion of blood. This is usually accomplished by transmitting the blood from an artery of one animal to the vein or artery of another. It requires very careful technic and is comparatively dangerous since clotting may take place, disease may be transmitted and hemolysis may occur. It has, however, the advantage over normal saline infusion in that nourishment is supplied, oxyhemoglobin furnished and, furthermore, the added fluid is not so easily transuded out of the vessels or excreted so rapidly as salt solution and consequently tends to maintain increased pressure for a longer time.

Uses. 1. In collapse and shock from any cause, but especially from bleeding.

2. Poisoning by carbon monoxide (illuminating gas) after removing a portion of the blood of the patient by venesection.
3. Profound malnutrition.
4. Profound anemia of secondary type or from hemorrhage.
5. Protracted weakness or prostration.

Saline Infusion. This means the injection of normal or physiological saline solution, warmed to a temperature of 110°–115° F., toward the heart. Normal saline solution is 0.85 per cent. of sodium chloride, corresponding to about one full teaspoonful to a pint of water. This is the most popular of all infusion fluids, but is not generally considered as the best one on account of the absence of all other salts, especially calcium and potassium, which are needed in the tissues and, according to Jacques Loeb, prevent the poisoning by sodium chloride, and furthermore, since its reaction is not alkaline, it is not generally considered the best solution. In fact, it is now believed that hard drinking water, which contains calcium, is better than distilled water for making infusions. This is because pure sodium chloride injected intravenously is poisonous and normal saline solution in distilled water has a veratrine-like action upon muscle, i.e., increased contraction with prolonged relaxation, but if a slight amount of calcium is present this is prevented. Ordinary table salt usually contains some calcium.

Dawson's Solution. This contains 0.8 per cent. of sodium chloride with 0.5 per cent. of sodium bicarbonate.

Locke's Solution is probably the best of all according to most authorities. It contains Sodium Chloride 0.9 gm., Potassium Chloride 0.042 gm., Calcium Chloride 0.024 gm., Sodium Bicarbonate

0.03 gm., Dextrose 0.1 gm., and Distilled Water enough to make 100.0 mils. This solution contains the necessary salts, is alkaline and nutritive.

Ringer-Locke Solution is the same as Locke's solution without the dextrose.

Ringer's Solution adapted especially for laboratory work upon frogs and turtles contains 0.7 per cent. of sodium chloride with the chlorides of potash and calcium.

It is necessary in order to understand the effects of saline solutions in the body to know and understand such physiologic terms as filtration, diffusion and osmosis and the characteristics of isotonic, hypotonic and hypertonic solutions. This is better discussed in the texts on physiology than can be attempted in this work. Since large amounts of fluid are passed into the blood in infusion, solutions should be as near isotonic with the blood as possible for the following reasons:

If a hypertonic solution is used, i.e., one that contains too much salt, the blood abstracts fluid from the tissues, which still further dilutes it and increases its volume. Furthermore, a strong hypertonic solution would injure the blood cells. On the other hand, a hypotonic solution tends to lake the blood. The effects of salines also differ greatly according to whether the volume of the blood has been reduced below normal or not.

When the Volume of Blood Is Not Decreased. There is so strong a tendency in normal animals for the blood to regain its normal condition that the regulating mechanism starts almost as soon as the infusion is begun. The increased blood pressure causes an increased pouring out of weak lymph and this is followed by the elimination of liquid through the intestines and kidneys (Starling), so that according to Crile the volume of blood will return to normal within half an hour and its constituents regain the usual proportions.

On account of the above actions, the addition of saline has only a transitory mild effect upon blood pressure, and chiefly increases urination and tendency to edema.

Crile found, further, that the dilution of the blood does not prevent the action of circulatory stimulants; and that if vasoconstrictors are administered at the same time as the infusion, the pressure could be raised above normal for a time; but when the splanchnic arteries were excluded, the dilution of the blood took place so rapidly with the progress of the infusion that edema set in very rapidly although the pressure was not necessarily raised. Hence in intravenous infusions, since the fluid must pass to the right heart and to the lungs first, pulmonary edema is favored; and especially is this the case if at the same time there is a marked back pressure in the left heart from constriction of the peripheral arterioles.

Therefore, as might be expected, pulmonary edema is readily brought about by a combination of saline and adrenaline.

Summary. When the volume of blood has not been reduced, saline infusion is generally useless to raise arterial pressure, and by producing edema may cause serious consequences. If used as a medium for the administration of drugs, it should be supplied in small quantities and slowly introduced.

When the Volume of Blood Is Notably Below Normal as After a Severe Hemorrhage. According to Levin, 25—50 per cent. of an animal's blood may be removed and replaced with normal saline solution without serious consequences. Crile found that after a moderate hemorrhage a saline infusion would increase the volume of blood and maintain a normal arterial pressure for a considerable time. He found also that the period of coagulation was reduced, infusion evidently favoring the cessation of the hemorrhage. Consequently salines are valuable to replace the lost blood and may be used with advantage whether bleeding has stopped or not. A few other observations by Crile are: The temperature of the infusion, if within reasonable limits, has little if any effect upon the temperature of the patient or the heart beat. The rate of flow makes no difference in the extent of the effect upon arterial pressure. The effect upon respiration is an increase in frequency and depth, but from greater than safe amounts, the breathing becomes slowed and there regularly follow edema of the lungs and death from respiratory failure.

Therapeutics. 1. In hemorrhage to restore the volume of blood to normal and thus permit the maintenance of blood pressure. At the same time if the hemorrhage is still in progress, the infusion may check it by increasing the coagulability of the blood (as in hemorrhage from injury or operation). Oxygen may first be passed through the fluid, since it is found that if the saline is saturated with oxygen, it favors the transference of oxygen to the tissues at the capillaries.

2. In toxemic conditions to promote kidney activity and hasten elimination of the poison. Levin does not consider bleeding followed by infusion as reliable treatment in toxemias since he was unable to get appreciable results in artificial toxemias. In nephritis with edema, salt retention contraindicates the use of salines.

3. In severe collapse and shock a small saline infusion combined with adrenaline (of about 500 mils, in man), given slowly and repeated as necessary, may produce and maintain blood pressure. Large infusions or one containing much adrenaline simply favor edema. A saline may replace the blood lost in an operation and prevent or favorably influence post operative collapse but care should be used not to overdo it.

Saline by Hypodermoclysis and Per Rectum. Saline may

be administered per rectum or by hypodermoclysis in case of collapse after hemorrhage, when it is desired to promote kidney activity. The absorption from the rectum is especially rapid following hemorrhage and considerable may be given by enema without expulsion. Under ordinary conditions hot saline solutions by rectum regularly show a prompt effect upon the kidneys. Considerable amounts may be absorbed within a short time from hypodermoclysis over the abdomen, in the axillary region and places where the skin is loose.

Contraindications. Any kind of edema.

Toxicology. Chills have been reported following saline infusions in human. Concentrated salt solutions are very dangerous.

4. VASO DILATORS

The most important members of this group are the nitrites of amyl, ethyl and sodium, and the organic nitrites which liberate nitrites in the blood, nitroglycerin, erythrol, tetranitrite and manitol. The alkaline nitrates have no effect upon the blood pressure, but potassium nitrate forms nitrite when burned, although it does not do so in the body.

AMYLIS NITRIS — AMYL NITRITE

Dose. Horse and Cattle. ♏x—lx; 0.6—4. Dog. ♏j—v; 0.065—.325.

This is an unstable volatile liquid with banana-like etherial odor. It decomposes slowly when exposed to the air. On account of its characteristics it is marketed in amber glass ampules, each containing two, three, four or five minims. The drug is administered by inhalation. An ampule is broken in a handkerchief or piece of gauze when desired for use.

SODII NITRIS — SODIUM NITRITE

Dose. H. gr. x—lx; 0.6—4. D. gr. ss—v; 0.03—0.3.

This is a non-volatile, non-explosive, deliquescent salt which is freely soluble in water. On account of its affinity for oxygen, it gradually oxidizes to nitrate in the presence of air and loses its efficiency, so that it is uncertain in action.

GLYCERYL TRINITRATE — NITROGLYCERIN

Synonyms. Trinitrin or Glonoin

This is the volatile highly explosive liquid used in the manufacture of dynamite, but it is decomposed and rendered non-explosive by strong alkalies.

Dose. H. gr. ⅕—½; 0.013—0.03. D. gr. 1/100—1/60; 0.0006—0.001.

It is official as *Spiritus Glycerylis Nitratis* (Spirit of Glonoin), Spirit of Nitroglycerin, a 1 per cent. solution by weight.

Dose. H. ʒss—ij; 2—8. D. ♏ j—iij; 0.05—0.2 mil.

Erythrol Tetranitrite is a slightly volatile solid, insoluble in water and very explosive.

Dose. D. gr. 1/6—j; 0.01—0.05.

Spiritus Ætheris Nitrosi, Sweet Spirits of Nitre, is a 4 per cent. by weight, alcoholic solution of Ethyl Nitrite. It is too mild to be used as a general arterial dilator but is used in colds and slight fevers as a diuretic.

Potassii Nitras, potassium nitrate (Kalium nitrate, nitre, saltpeter) is a constituent of gun powder, but is non-explosive. It is used in human practice for its nitrite action, by burning unsized paper impregnated with it, to relax the spasmodically contracted bronchial muscles in asthma.

Action Circulatory System.

Arteries. These are dilated by direct depression of the arterial muscles, as is shown by the fact that the flow of fluid will increase

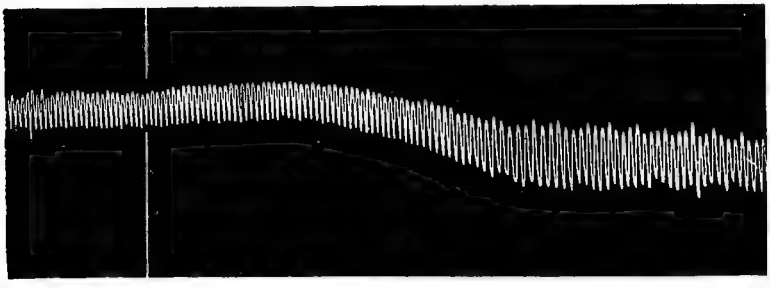

Fig. 14.—Blood Pressure tracing. Horse. Effect of Nitroglycerin upon blood pressure. (Tracing made by Dr. P. A. Fish.)

greatly when a nitrite is added to the perfusing fluid, and since, if the experiment is so carried out that the blood from the carotid will reach the medullary centers, but is prevented from getting into the general circulation, the injection of a nitrite into the carotid does not cause a fall in blood pressure. It is, therefore, believed that the centers are not involved. On the other hand, it is not known just how much of the action is due to the effect upon the nerves and muscles but the dilatation takes place in the pulmonary arteries which have no vasomotor nerves, so it is generally believed that the action of the nitrites is due to direct depression of the arterial muscles and they are, therefore, considered as true arterial dilators.

The arteries of the splanchnic area appear to be most affected by nitrites but the dilatation is also pronounced in the arteries of the extremities and in the cerebral, coronary and pulmonary arteries. The veins are also somewhat relaxed, but this is not important.

Heart. The heart's action is accelerated on account of depression of the vagus. That the depression is due to this action is shown by the fact that if the vagus endings are first paralyzed by atropine, there is no additional increased rate of the organ. But, there is still some controversy whether the depression of the vagus is due to direct action upon the vagus center, or whether it is the regular reflex depression which accompanies lowered arterial pressure.

Summary.

1. Depression of the arterial muscles resulting in dilatation of their arteries. 2. Increased rate of the heart. 3. Perhaps some increased tone and strength of the heart.

Blood. When mixed with a nitrite the oxyhemoglobin of the blood is converted into methemoglobin. This compound is more stable than the oxyhemoglobin and cannot serve as a carrier of oxygen, but harmful effects rarely follow the administration of medicinal doses. The nitrites differ somewhat from the other methemoglobin formers in that they do not destroy the red corpuscles and after a time the methemoglobin is reduced in the tissues to oxyhemoglobin. If present in the blood in large amounts, methemoglobin causes dyspnea and cyanosis; but if placed under a jar containing oxygen under pressure, animals usually recover from this poisoning by the nitrites.

Respiratory System. The respirations are quickened and deepened but this is probably due to changes in the circulation (*increased supply of carbon dioxide to the medullary centers*). From very large doses there is later a depression of the center and asphyxia.

Nervous System. There is no direct action upon the brain but the cerebral arteries are dilated along with the others, and on account of this or the rapid fall of pressure, there may be dizziness and momentary throbbing of the head and faintness. The respiratory center is stimulated, the vagus center depressed.

Muscles. Other forms of plain muscles (ureters, bronchioles and intestines) are relaxed, but not to the same extent as are those of the blood vessels. With the exception of the heart, striated muscle is not affected.

Temperature. This may be lowered on account of dilatation of the vessels of the skin and increased secretion of sweat but this action is not marked.

Excretion. Excretion of the nitrites is largely by the kidneys as the nitrates but any increase in the secretion of urine is secondary to the action of the drug upon the circulation and depends upon the relative dilatation of the renal arterioles and those of the general cir-

culation. If those of the kidneys are relatively more dilated, diuresis takes place.

Differences in Members and Administration. The members of this group differ mainly in rapidity and persistence of action. Amyl nitrite, inhaled, is the most rapid and least persistent. It will produce action in from 10 to 15 seconds which will last about 3 minutes. Nitroglycerin may be given per os or hypodermically and is almost immediately absorbed. The fall in blood pressure starts in ½ to 3 minutes, reaches the maximum in 5 to 15 minutes, and disappears in ½ to 1 hour. *Sodium nitrite* is to be given per os and is less rapidly absorbed. Its action starts in from 5 to 30 minutes, reaches its maximum in 20 to 80 minutes and is completely over in 1 to 2 hours. *Erythrol tetranitrite* is also given per os. Its action is still slower. The fall in pressure begins in from 5 to 30 minutes, reaches its maximum in from ½ to 2 hours later and disappears in from 2 to 5 hours.

Mannitol has about the same action as erythrol.

Therapeutics. The nitrites are used almost entirely to relax constricted arteries and bronchi. The uses may be summarized as follows:

1. To relieve excessive resistance to the work of the heart, as in arteriosclerosis.

2. Antispasmodic: Inhalations of amyl nitrite may be of service in the spasms of epilepsy, tetanus and strychnine poison and to relieve asthmatic seizures in the dog.

3. They have some indication to lower blood pressure in hemorrhage, although one would expect to counteract any beneficial action by dilatation of the bleeding vessels.

4. In toxic rise of blood pressure; poisoning from digitalis, strychnine, barium and in lead colic.

5. As a diuretic and diaphoretic in colds and mild fevers, Spirits of nitrous ether.

6. Amyl nitrite may be useful to overcome chloroform poisoning on the theory that it overcomes resistance and saves an exceedingly weak heart. According to Mühlberg and Kramer, it is effective in preventing the stoppage of the heart in the first and second stages of chloroform and ether anesthesia, although chloroform containing 2 per cent. of amyl nitrite is more toxic than when used alone.

The second and fourth uses are the only ones of importance in veterinary medicine.

℞ Spiritus Glycerylis Nitratis ..... ♏ xv
Glycerini ..... ʒ ijss
Aquæ Destillatæ ..... ʒ iij
M. Ft. Solutio.
Sig. Teaspoonful three times daily for a dog with pulmonary emphysema.

MEASURES FOR DECREASING THE VOLUME OF BLOOD. VENESECTION, PHLEBOTOMY, BLEEDING

Bleeding is one of the oldest therapeutic measures and was frequently employed in the older systems of medicine, but has been almost discarded. A careful examination of its former uses has shown that in most of these it was not only useless but in many cases decidedly harmful, particularly so in its use in febrile and inflammatory conditions in general. On the other hand, there are some cases in horse and cattle practice in which it may be of decided benefit.

Venesection is the process of removing blood by opening a vein. The jugular vein is the one most used in large animal practice, but in the days when bleeding was the regular custom it was a common practice to bleed from the palatine veins and arteries, although only comparatively small amounts of blood were drawn from these sources. The usual method of bleeding was to raise the jugular with the finger or tourniquet, and then open it with a bistury or phleme and allow the desired quantity to escape. The bleeding was then stopped by a skin suture or pin suture through the skin retained by a figure eight string or horse hair. *See works on surgery.*

The most marked effect upon the body of the removal of large amounts of blood (5 to 10 quarts in horses and cattle) is the withdrawal of a large amount of water, which agrees very closely to the effects of diaphoretics, diuretics, sialogogues and laxative drugs. Following this, there is a tendency for the blood to regain its normal volume as quickly as possible by taking up the fluids at its disposal, lymph, fluid exudates, causing a temporary hydremia. This action is the basis for the principal use of blood letting. Blood pressure also usually falls. In addition to the above, there is a derivation of the blood from the internal organs, and the more rapidly the blood is withdrawn from the veins the more promptly this action occurs.

The General Uses of Blood-Letting Are:

1. In conditions of high blood pressure.

a. In inflammation of the brain; in the early stages so long as the symptoms of cerebral congestion are pronounced, such as, congestion of the visible mucous membranes of the head, increased temperature of the cranium, strong pulsation of the arteries of the head and symptoms of excitement.

b. Laminitis. According to Fröhner, free bleeding as early as possible, together with the use of arecoline is the best treatment for this disease.

c. High blood pressure of eclampsia and uremia in human medicine.

2. In conditions of venous engorgement with heart weakness, especially in edema of the lungs.

3. To remove poisons, carbon monoxide, toxins, etc. It is of very doubtful value in removing poisons since Levin, experimenting with artificially introduced toxins, met with negative results. In carbon monoxide poisoning, blood-letting is a good procedure, provided it is followed by transfusion of blood, because the poison is in the circulating blood.

4. It has also been recommended as a curative measure in azoturia and as a prophylactic agent against parturient apoplexy of cattle. It is also used in some sections in the beginning of fattening animals.

Venesection for the relief of marked local congestions was at one time a favorite practice in human medicine, but not in veterinary medicine. It was carried out by wet and dry cupping and leeches.

In wet cupping a few small incisions were made close together in the skin and a cup was applied over them. The suction was obtained either by exhausting the air in the cup with a pump or by burning a small amount of alcohol in it before it was applied. Only a small amount of blood was obtained by this method.

In dry cupping the same method was pursued, with the exception that no incisions were made and consequently only edema or local congestion resulted.

Leeches are small animals (Hirudo). They were placed upon the desired part of the skin and allowed to remove a small amount of blood.

CHAPTER IX

ANTIPYRETICS OR FEBRIFUGES

These are agents used to reduce the temperature of the body in fever, but most of them will not reduce a normal temperature. The constant temperature of warm blooded animals depends upon a proper balance between heat production and heat dissipation. Heat is largely produced in the muscles and glands, and is largely lost through the lungs, feces, urine, etc. The normal balance is maintained by the heat regulating mechanism.

The circulation is an important factor both in heat production and heat loss, since the vessels of the skin not only form a cooling apparatus for the dissipation of heat produced in other parts of the body (radiation) but also lessen its production in the following manner: When the vessels of the skin are dilated, the blood not only flows through them much more quickly and is cooled, but being withdrawn from the muscles and glands, their activity is reduced and consequently less heat is produced. The opposite is also true when the cutaneous vessels are contracted. Since the condition of the vessels is regulated by the vasomotor center, drugs acting upon it may greatly modify body temperature.

This group known as antipyretics will include only those drugs whose most prominent action is to reduce temperature in fevers. It does not include aconite, digitalis, alcohol, camphor, etc., which have the power to lessen fever, but have at the same time more important actions which have led to their grouping elsewhere.

For convenience of study, antipyretics may be divided into three therapeutic groups: the quinine (or antimalarial group of human medicine), the coal tar or analgesic, and the salicylates or antirheumatic.

CINCHONA

Synonym. Peruvian Bark.

Two varieties of Cinchona are official, Cinchona (yellow cinchona) and Cinchona Rubra (red cinchona). They are the dried barks of certain species of cinchona yielding 5 per cent. of the alkaloids of the respective variety. The fluidextract and tincture are made from cinchona and the compound tincture from the red variety.

Active Principles. Cinchona contains some eighteen or nineteen alkaloids, the four principal ones being quinine, quinidine, cin-

chonine, cinchonidine; and its action is based principally upon that of quinine. The action of the other alkaloids is similar to quinine but weaker. Quinine may be obtained in any of the following salts:

Quininæ sulphas, soluble in 720 parts of water, in 86 of alcohol, freely soluble in dilute mineral acids as it here forms the double salts; bisulphate, etc.

Quininæ Bisulphas, soluble in 8.5 parts of water and 18 of alcohol.

Quininæ Bromidum, soluble in 40 parts of water and 0.67 of alcohol.

Quininæ Chloridum, soluble in 18 parts of water and 0.6 of alcohol.

Quininæ Salicylicum, soluble in 77 parts of water and 11 of alcohol.

Cinchoninæ Sulphas, soluble in 58 parts of water and 72 of alcohol.

Quininæ et Ureæ Hydrochloridum is a double salt, soluble in its own weight of water and suitable for hypodermic use. It is anesthetic and non-irritating, but not stable in solutions.

Euquinine (Quinine-ethyl-carbonic-ester) is insoluble in water and therefore not bitter. It is also said to be followed by less disagreeable effects. Its dose is about twice that of quinine, but it is not used to any extent in veterinary medicine.

Preparations and Doses.

Fluidextractum Cinchonæ and Bark, Astringents. H. 3ijss —vj; 10—25. D. 3ss—j; 2—5.

Extractum Cinchonæ. H. 3ss—ij; 2—8. D. grs. v—xxx; 0.3—2.

Tinctura Cinchonæ 20 per cent. D. 3ss—ij; 2—4.

Tinctura Cinchonæ Composita (10 per cent. with orange peel and serpentaria). Dose, double the tincture.

Quininæ Sulphas Tonic. H. grs. v—xxx; 0.3—2. D. grs. j—ij; 0.065—.130. Antipyretic. H. 3ij—viij; 8.—30. D. G. grs. iij—xv; 0.2—1.

Quininæ et Ureæ Hydrochloridum. Quinine and urea hydrochloride. D. gr. ij—xv; .013—1. Hypodermically in a few drops of water.

Tinctura Antiperiodica. N. F. Warburg's Tincture. According to Bastedo, this is a bitter, aromatic, laxative, sedative and antimalarial "gunshot" prescription. It contains quinine sulphate, aloes, rhubarb, angelica seed, elecampane, saffron, fennel, prepared chalk, gentian, cubebs, myrrh, white agaric, opium, black pepper, ginger, alcohol and water. Each ounce contains 10 grains (0.63) of quinine, 8 grains (0.5) of extract of aloes, and 1/8 grain (0.008) of opium. Dose for the dog would be about 1 dram. Warburg's tincture without aloes (sine aloe) is the same with the omission of the

aloes. It can also be obtained in pill form for both preparations, each pill representing one dram of the corresponding tincture, Pilulæ Antiperiodica, N. F.

Local Action. Quinine is quite a powerful antiseptic. A solution of 1—500 destroys many forms of micro-organisms, and a solution of 1—250 prevents fermentation and putrefication.

It is very toxic to the lower forms of animal and vegetable life. In dilute solutions the tendency is to irritate or stimulate protoplasm but this is soon followed by depression, and in motile organisms, as protozoa, ameba, etc., all motion is soon stopped, while strong solutions instantly stop the movements and kill them. It has no action when applied to the unbroken skin, but is irritant to raw surfaces, causes considerable pain when given hypodermically and often causes abscess formation.

Digestive System. In small doses it resembles the vegetable bitters. The secretions from the salivary and gastric glands and the blood supply to the stomach and intestines are increased. There is some belief that it also increases peristalsis and on account of the above actions it has been commonly used as a bitter to increase the appetite and digestion. *Large doses* are irritant to the digestive tract, causing nausea, vomiting and diarrhea.

Circulatory System. Small or medicinal doses may increase the force and frequency of the heart's beat but it is not used for this purpose. Large doses depress the heart, while toxic doses paralyze that organ and arrest it in diastole. Small doses slightly raise blood pressure, and larger ones lower it.

Blood. Quinine arrests the ameboid movements of the leucocytes and prevents their migration in inflammatory conditions. Even when the inflammation has begun, strong solutions of quinine stop the transmigration of the leucocytes and their gathering to form pus at the site of inflammation, and although such large doses cannot be used in practice, some influence is shown, for their number may be strongly reduced. The polymorphonuclear variety is much more reduced than the others. Roth found a temporary increase in the lymphocytes which after several hours changed to a decrease. The coagulability of the blood is decreased. Large doses lessen the number of red cells while therapeutic doses increase the number and per cent. of these cells. These diminish in size in febrile conditions but under the influence of quinine and other antipyretics regain their normal condition. It is believed that quinine also impairs the oxygen carrying power of the red blood cells and the ozonizing power of the blood.

Nervous System. Small doses stimulate the cerebrum, while large doses cause cerebral congestion with a sense of fullness of the head in man. The reflex function of the spinal cord is reduced by small doses and abolished by toxic ones. The muscles are unin-

fluenced, though if applied locally it is an irritant and may cause contraction.

Peripheral Nerves. A slow prolonged anesthesia follows the hypodermic injection of quinine and urea hydrochloride at the site of injection.

Respiratory System. Small doses have no influence upon respirations, but large or toxic doses paralyze the respiratory center.

Temperature. In health there is no effect upon the temperature but in febrile conditions it is an antipyretic. This action is due almost entirely to diminished production of heat and, since it lowers temperature after division of the spinal cord, it does not exert this action through the heat regulating center. Its action as an antipyretic can be further explained as due to:

1. Antiseptic action. There is some belief that it overcomes the infection which is the cause of the fever, and consequently the fever is reduced.
2. Lessened reflex excitability.
3. Diminished oxidation.

Uterus. It is believed by some to be an abortifacient although there is little direct proof of this action. There are indications, however, that it may be of some use in labor after this has started but the contractions are not tetanic as in case of ergot and pituitary extract.

Kidneys, Metabolism, Elimination. Quinine lessens the secretion of uric acid and to some extent that of urea. It is chiefly eliminated by the kidneys but is more or less unabsorbed and passes out with the feces. Slight amounts are also eliminated by the bile, tears, saliva and milk.

Upon the Plasmodium of Malaria. Quinine is a specific poison for this organism.

Cinchonism. In man a condition is sometimes seen after repeated doses or large doses, which is known as cinchonism. This is manifested by eruption of the skin, itching, disturbance of vision, impairment of hearing and a sense of fullness of the head. It is treated with potassium bromides or hydrobromic acid.

Therapeutics.

1. *Locally.* Quinine and urea hydrochloride in solution have come into extensive use as a local anesthetic. Hertzler, Brewster and Rogers consider it suitable for all operations in man that can be done under cocaine. They use a 0.25 per cent. solution in normal saline, and have determined that stronger solutions retard healing. Some operators use solutions of 1 to 3 per cent. In order to lessen the liability to shock in human work, Crile uses it in major operations, to anesthetize the field of operation before cutting, to cut off all afferent impulses. The bisulphate of quinine has also been used as a local anesthetic.

2. *For Oxyures or Pin Worms.* A $\frac{1}{2000}$ to $\frac{1}{500}$ of the bisulphate or a 0.5 per cent. solution of quinine and urea hydrochloride have been used with some success as a rectal injection for these parasites.

3. *Antiseptic for Diseases of the Eye.* A 1 to 2 per cent. solution of quinine sulphate is serviceable for suppurating conjunctivitis, keratitis and ulcer of the cornea.

Internally.

1. *Bitter.* One of the preparations of the crude drug is generally superior to the alkaloids as a bitter. The compound tincture is often preferred. Bastedo does not class quinine or cinchona as a true tonic since it has a tendency to retard absorption, inhibits proteolytic enzymes, irritates the stomach and does not have any good effect upon muscle.

2. *Antipyretic.* Quinine is inferior to acetanilid and the newer antipyretics as a febrifuge against high and continued fevers. According to Fröhner, it does not have a pronounced action upon the typical infectious diseases like influenza and brustseuche (contagious pleuro pneumonia) of horses and distemper of dogs. He says that he has given 100 grams in two days to a horse with influenza with no results. But he believes it somewhat better for fevers caused by infection like septicemia and pyemia, although in the light of present day knowledge it would seem to be liable to do more harm than good by checking phagocytosis and depressing vitality.

3. *Antimalarial.* Although quinine has a specific action for the malaria parasite of man, it has not proved of much service in malarial-like conditions of animals (horse and cattle malaria of Italy), nor in Texas fever and trypanasomiasis.

4. *Analgesic and Antipyretic in Colds.* According to some authorities, quinine may be abortifacient if administered in full doses at the onset of inflammations of the respiratory tract and in colds but later in the disease it is without benefit until the convalescent stage is reached when it may serve as a bitter.

5. *Pneumonia.* Solis-Cohen in human practice used 15 grains of quinine and urea hydrochloride hypodermically every 2 to 3 hours for 3 or 4 doses and claims that fever disappears by lysis instead of crisis, but this has not been confirmed by practitioners of veterinary medicine.

COAL TAR OR ANALGESIC GROUP OF ANTIPYRETICS

This group comprises:

Acetanilid	Exalgin
Phenacetin	Lactophenin
Antipyrine	Salipyrine

ACETANILIDUM ACETANILID

Synonyms. Antifebrin, phenyl-acetanide

Acetanilid is prepared by the action of glacial acetic acid upon analine, an atom of H in aniline being replaced by an acid radicle. It occurs as a shining white powder or light shiny scales, soluble in 180 parts of water, freely soluble in alcohol (2.5 parts).

Preparations and Doses.

	Single doses	Daily doses
Horses and cattle	ʒ iv—viij; 15—30.	℥ jss—iv; 45.—120.
Sheep	ʒ ij—iv; 8—15.	ʒiv—℥j; 15.—30.
Dogs	gr. iv—xv; 0.25—1.	gr. viij—xxx; 0.5—2.
Cats	gr. ij—v; 0.1—0.25.	gr. iv—xv; 0.25—1.

Pulvis Acetanilidum Compositus Compound acetanilid powder, acetanilid 7, caffeine 1. Sodium bicarbonate 2.

Incompatibles. Incompatible with caustic soda and potash, and chloroform.

External and Local Action. Acetanilid is an antiseptic, astringent and hemostatic.

Digestive System. There is no important action upon this system.

Circulatory System. This drug has been claimed as a cardiac depressant in man because a few cases of collapse have followed its use, but ordinary doses in experimental animals have no marked effect upon the circulation. In fact, small doses may slightly quicken

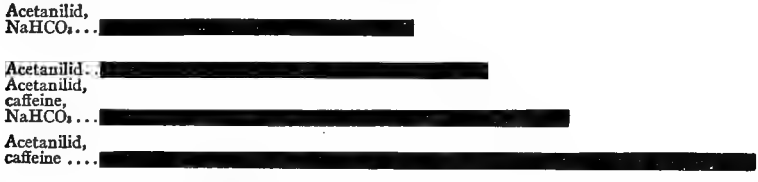

FIG. 15.—Toxicity of acetanilid increased by caffeine, decreased by sodium bicarbonate. Experiments on mice by Worth Hale. The degree of toxicity is represented by the length of the bars.

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the heart and strengthen the beat due to a direct action upon the cardiac muscle, but in large doses the heart muscle is weakened, slowed and irregular, causing collapse. The collapse action, however, is not marked and when it follows moderate doses should be attributed to an idiosyncrasy. Caffeine has been added to acetanilid in the hope of overcoming the depressant action upon the heart but Worth Hale has shown that acetanilid is more toxic when administered with caffeine but less toxic when given with sodium bicarbonate.

The skin vessels are dilated in fever probably through action on the heat regulating center.

Nervous System. Acetanilid is a powerful analgesic, and a slight sedative to the nerves and cord. Small doses are slightly stimulant to the brain, larger ones may be sedative and tend to produce drowsiness. Large or toxic doses may excite convulsions which appear to be of spinal origin in some cases, of cerebral origin in others.

Temperature. In health single or moderate doses do not have any influence upon temperature, but in fever acetanilid is a very strong antipyretic. Its antipyretic action is due almost entirely to action upon the heat regulating center. It does not in any way reduce heat production because it does not reduce metabolism. It is believed that it aids the heat regulating center to improve its control over the mechanisms of heat dissipation, which are the ones at fault in infectious fevers. This central action is shown by the fact that it does not lower normal temperature, if the cord is divided, and by the fact that there is no effort made by the organism to produce more heat, shivering, etc., as when the temperature is lowered by cold applications. The reduction of temperature may be accompanied by sweating but this is of central origin and temperature will still be lowered if the sweating is prevented by atropine. Its effects are usually produced promptly and last for several hours.

Absorption, Elimination and Metabolism. It is absorbed rapidly and soon excreted as oxidized products. It is a feeble diuretic, increases urea and uric acid, and renders the urine darker in color.

Therapeutics.

1. In fevers to reduce the temperature when dangerously high and to promote the comfort of the animal by lessening pain.

2. Analgesic. It is especially valuable for the relief of the "so-called" functional pains in man, neuralgias, etc., but is less important to veterinarians for this purpose although Quitman gives acetanilid analgesic properties in horses.

3. Laminitis. It has been reported as very successful in the German army for the treatment of this disease. In this case large doses (ʒiv—viij) are given three or four times daily.

4. Externally. As a dusting powder for wounds, galls, etc., either alone or in combination with boric acid, talcum, etc.

ANTIPYRINA. ANTIPYRINE

Synonym. Analgesin

This is also a coal tar product. It is obtained by the action of phenyl hydrazine upon diacetic ether and then methylating the re-

sulting monœthyl compound. It occurs as fine crystalline scales, odorless and of a bitter taste. It is freely soluble in water, alcohol and chloroform.

Doses. H. 3ij—vj; 8—24. D. grs. iv—lx; 0.25—4.

ACETPHENETIDINUM

Synonym. Phenacetin

For some years this preparation was proprietary as *phenacetin* but in the 8th revision of the Pharmacopœia it was made official under the above name. It is obtained by the action of paraphenetidin, a coal tar derivative, upon glacial acetic acid, in which an atom of hydrogen in the paraphenetidin is replaced with the acetic acid radicle, acetyl. It occurs in colorless, odorless, tasteless scales, soluble in 12 parts of alcohol, in 925 parts of water and in glycerin.

Doses. H. Too expensive for large animals. D. gr. ij—xxx; .13—2.

In the main these drugs act similarly to acetanilid. Acetanilid is probably the most depressant to the heart and therefore most liable to cause collapse and phenacetin the least. Phenacetin is probably the least toxic. Antipyrine is a better hemostatic than acetanilid or phenacetin. Both of the above drugs are much more expensive than acetanilid and therefore of little use in veterinary medicine since acetanilid is relatively safe for the lower animals, and consequently the newer preparations have little advantage over it.

Therapeutics. In general these drugs are used for the same conditions as mentioned under acetanilid. Antipyrine, in addition, has a weak cocaine-like action in 25 per cent. solution when applied to mucous membranes, causing a vaso-constriction with shrinkage of the tissues and thus checking small hemorrhages and lessening pain.

SALIPYRINA — SALIPYRINE

This is a combination of antipyrine and salicylic acid and is therefore valuable as an antirheumatic and antipyretic. It may be substituted for either of its constituents or for a combination of the two.

OTHER MEMBERS OF THE GROUP

Exalgine resembles acetanilid except in its greater insolubility in water and may be given in the same quantity. Chemically it is methyl-acetanilid. It occurs as white crystals, soluble in alcohol, sparingly soluble in water. It has an acetanilid-like action as an analgesic but is not to be used as an antipyretic according to Hare.

Phenalgin (phenolated acetanilid). A white powder of slight

pungent odor, no pronounced taste and nearly insoluble in water. Uses the same as acetanilid.

Lactophenin (lactyl-para-phenetidin) differs chemically from phenacetin only in having lactic acid in place of the acetic acid constituent. It is an antipyretic and analgesic.

Migranum is a mixture consisting, according to an analysis made at the chemical laboratory of the American Medical Association, of antipyrine, caffeine, and citric acid.

Anilipyrine is made by melting together 376 parts of antipyrine and 135 parts of acetanilid. It is antiseptic and analgesic.

Iodophenin or iodophenacetin results from the precipitation of a solution of phenacetin in hydrochloric acid with potassium iodide: brown powder containing about 50 per cent. of iodine, insoluble in water, soluble in alcohol. Used as a wound dressing and antirheumatic.

Iodopyrin (iodoantipyrine) antipyrine iodide, colorless crystals, soluble in alcohol, slightly soluble in water. Analgesic and alterative in tuberculosis, neuralgia, etc.

Apolysin is a substance closely related to phenacetin, a citro-paraphenetidin or monocitryl-paraphenetidin. White powder, of faint odor and acidulous taste, moderately soluble in water, more freely so in alcohol or glycerin. Used as an antipyretic and analgesic. It is claimed to be comparatively nontoxic and noncumulative.

Thermodin is phenacetin-urethane. It consists of colorless, odorless and tasteless crystals, soluble in 2600 parts of water and is used as antipyretic and analgesic the same as acetanilid.

Neurodin is the trade name for acetyl-para-oxyphenyl-urethane. It occurs as colorless, odorless crystals, slightly soluble in water. Antineuralgic and antipyretic.

GROUP OF THE SALICYLATES OR ANTIRHEUMATIC ANTIPYRETICS

ACIDUM SALICYLICUM — SALICYLIC ACID

Salicylic acid is chemically ortho-salicylic acid. It is an organic acid which exists naturally in the volatile oils of wintergreen and birch but is generally prepared synthetically from phenol. The synthetic acid has been found contaminated with meta and para salicylic acids and with cresotonic acid, which are said to be depressing to the circulation, but the commercial acid of the present time is fairly pure and the reported superiority of the natural product is not substantiated as shown by Eggleston, Hatcher and others. Furthermore, Engelhardt found phenol present in a number of samples of both the artificial and the natural acids.

Salicylic acid occurs as small, white needle-like crystals, or a light crystalline powder, odorless, with a sweetish, afterward acrid burning

taste. One gram dissolves in 460 mils of water and 2.7 mils of alcohol. It is freely soluble in ether. It is also much more soluble in solutions of neutral salts, such as the borates and citrates, than in water.

Preparations and Doses.

Single doses	Daily doses
H. 3ii—ℨjss; 8.—45.	ℨiijss—100.
C. 3ii—ℨij; 8.—60.	ℨvj—150.
D. grs. iij—xv; .2—1.	3iij—2.8
Cat. grs. jss—iij; 0.1—0.2.	gr. viij—.51

There are also the alkaline salts of sodium, lithium, strontium and magnesium with an action similar to that of the acid. Sodii Salicyclas — Sodium Salicylate — is most frequently used. The dose of the salts is twice that of the acid.

The salts of ammonium, quinine, bismuth and physostigmine are also official but in the available dose do not produce a salicylate-like action.

Incompatibles. It is incompatible with mineral acids, alkalies and metallic salts.

External and Local Action. On microorganisms: Solutions of 1—500 are antiseptic and will therefore inhibit or check the growth of bacteria, moulds and yeasts. These solutions are not corrosive to protoplasm or poisonous to animals and except in large amounts are safe to use in and upon the body. It is not a popular antiseptic, largely on account of its insolubility, but is largely used in the treatment of skin diseases and for the preservation of food. It belongs to the phenol group of antiseptics but differs from phenol in not having the destructive and penetrating properties of that agent and in retaining its antiseptic properties in alcoholic and fatty preparations. The alkaline salts have some antiseptic action, though less than the acid, and are soluble in water. Their use, however, as antiseptics is mostly confined to the preservation of foods. Salicylic acid is also a parasiticide and antiferment.

Salicylic acid is irritant to mucous membranes, softens the epidermis as in the removal of corns without exciting inflammatory changes beneath and promotes the healthy growth of skin in chronic skin diseases. Solutions of the acid check perspiration through external application. In addition to the above action the oils of wintergreen and birch are counterirritants.

Digestive Tract. Even small doses tend to delay digestion by inhibiting or diminishing the action of the digestive enzymes. A 1 per cent. solution is sufficient to check the action of ptyalin on starch. Pepsin is also somewhat retarded and it is believed that the other secretions are acted upon in a similar manner. Salicylic acid is a distinct irritant to the mucosa of the stomach and frequently

causes nausea and vomiting in those animals capable of vomiting and on this account the sodium salt is most often used because it is less irritating to the stomach. The acid has some reputation as an antiseptic upon the contents of the stomach but there is much doubt concerning its effect upon the number of bacteria. The volatile oils are carminative.

Circulatory System. Small doses may slightly raise blood pressure, according to some authorities, by some probable constriction of the deep vessels by central action. The peripheral vessels are dilated. Larger doses are said to make the heart beat faster and stronger and raise blood pressure but toxic doses finally lower blood pressure. The migration of the leucocytes is restrained or checked but their number is increased.

Nervous System. There is very little action upon the nervous system. It is an analgesic like acetanilid but very much weaker. Toxic doses cause cerebral congestion and lessen reflex action but the method of action is unknown.

Respiratory System. There is no important action upon this system. Small doses stimulate, quicken and deepen the respirations through action upon the respiratory center and pulmonary vagi. Toxic doses paralyze the respiratory center and cause death by asphyxia.

Temperature. There is no effect upon the temperature of healthy animals through medicinal doses, but in febrile conditions the temperature will be lowered in a short time and remain down for several hours. Heat production is lessened and heat loss is increased.

Absorption and Elimination. The acid is not absorbed from the unbroken skin. It is converted into the sodium salt in the stomach and absorbed as such from the stomach and intestines. It is eliminated by most secretions but chiefly by the kidneys as salicyluric acid, although a part is eliminated unchanged. It is eliminated to some extent through the bile, milk, sweat and inflammatory exudates. Elimination is slow and on this account large doses taken continuously may be cumulative.

Urine. The total amount of urine is increased together with uric acid and urea.

Therapeutics.

Externally. 1. The acid may be used as a surgical antiseptic, in the form of a dusting powder, alcoholic solution or ointment.

2. To soften and remove callosities and warts, corns, etc., upon which it may be applied either as an ointment or in solution.

3. As a parasiticide for various fungus skin diseases, either in alcoholic solution or an ointment.

4. In human practice in an alcoholic solution to check excessive sweating of the hands and feet.

Internally. 1. As a specific for acute muscular or articular rheumatism. Here one of the salicylates is to be preferred. They lessen pain and swelling, lessen the danger of cardiac complications, and shorten the attack. The manner of action of the salicylates in these conditions is not well understood, but it is believed or suspected, at least, that they have a specific action against the infective agent. Fair sized doses should be given every two or three hours until improvement is seen and then less often. The salicylates have little influence upon chronic rheumatism except to check acute attacks of the disease.

2. Salicylic acid or the salicylate of sodium is often of considerable service to check excessive fermentation in the digestive tract, especially in gastric fermentation of the horse. The acid is usually preferred for this purpose and is given in capsule in 4 to 6 dram doses.

3. Antipyretics. These agents have been used as antipyretics but they do not compare very favorably with those of the previous group.

For Acute Moist Eczema.

℞ Acidi Salicylici.
Acidi Tannici .....āā 5.
Alcoholis q. s. .....ad. 100.
M. Ft. Sol. Apply to affected parts.

℞ Acidi Salicylici ..... gr. xv
Zinci Oxidi.
Amyli .....āā ʒ ii
Petrolati q. s. .....ad. ʒ i
M. Ft. Pasta.
For ring worms, etc.

PHENYLIS SALICYLAS — PHENYL SALICYLATE

Synonym. Salol

Phenyl salicylate is composed of 60 parts of salicylic acid and 40 parts of phenol. It is a white powder, of aromatic odor and taste, sparingly soluble in water, soluble in alcohol, ether and oils.

Doses. H. ʒij—viij; 8—30. D. gr. ij—xv; 0.13—1. Daily doses, gr. xv—lx; 1—4.

External and Local Action. This resembles the other salicylates and in addition is somewhat of a deodorant.

Digestive System. Salol is insoluble in the gastric juice and consequently passes into the intestines unchanged, where it is broken up by the alkaline pancreatic juice into its constituents, which are

easily absorbed. Furthermore, it is a non-irritating intestinal antiseptic. On account of its insolubility in the gastric juice salol is often used as a coating for pills which are intended for action upon the intestines. Poisoning takes place after large doses from the freed phenol.

Circulatory System. It is not so depressing as salicylic acid.

Absorption and Elimination. This is similar to that of the salicylates in general. Salol renders the urine aseptic and for this reason is used in inflammation of the bladder. It also renders the urine acid and causes the sediment to disappear.

Therapeutics.

1. Fermentations of the digestive tract.

2. As an intestinal antiseptic. Salol is very serviceable in all those cases needing an intestinal antiseptic, such as intestinal catarrh, distemper of dogs, etc. It is too expensive for large animals.

3. Rheumatism. Salol may be useful in this disease, although its action is less prompt than the salicylate of soda.

4. Antipyretic. It is inferior to the coal tar antipyretics but may be used for this action.

Other members of the salicylate group.

ASPIRIN — ACETYL SALICYLIC ACID

This differs from salol only in having an acetyl instead of a phenol radicle. It occurs as a white crystalline powder, soluble in 100 parts of water and 5 parts of alcohol. As in the case of salol it passes through the stomach unchanged, but undergoes dissociation in the intestines, liberating salicylic acid, but some may be absorbed unchanged and exhibit a more pronounced salicylate action than salol. It is used as an antirheumatic, intestinal antiseptic and analgesic in functional pains, headache, etc., in human medicine.

Novaspirin is the methyl-citric-ester of salicylic acid. It occurs as a white, odorless powder, of acidulous taste, is almost insoluble in water, freely soluble in alcohol. It contains 62 per cent. of salicylic acid and is intended as a substitute for the salicylates in various conditions.

Diaspirin is the succinic acid ester of salicylic acid, occurring as an odorless, almost tasteless, crystalline powder very sparingly soluble in the ordinary fluids but slowly decomposing in alkaline liquids. Used largely as aspirin but is more strongly diaphoretic.

Salicin is a glucoside obtained from the bark of the willow and poplar. It is bitter but not nauseating. In the stomach or duodenum it splits into salicyl alcohol and other close allies of salicylic acid. Its action is quite similar to those of the other salicylates but

milder. Its uses are confined to the milder rheumatic manifestations, or in conditions of the stomach where the ordinary salicylates cannot be administered.

Saliphen (salicyl-paraphenetidin) occurs as colorless crystals readily soluble in alcohol and almost insoluble in water, is a mild analgesic and antipyretic.

Salophen (acet-amido-salol.) It is a white, odorless, tasteless powder, soluble in alcohol, insoluble in water, contains 51 per cent. of salicylic acid and is decomposed by alkalies. It is an anodyne, antiseptic, antipyretic and antirheumatic. Used externally in 10 per cent. ointment.

Atophan is chemically phenyl-quinolin-carboxylic acid. Atophan stimulates the kidneys, increases the amount of urine and furthermore has a specific or selective action by which it increases the amount of uric acid excreted to a greater ratio than the increase in the amount of urine. It is claimed to have a more prompt and stronger effect on the excretion of uric acid than sodium salicylate. It is useful in gout of man, in which it acts more promptly than colchicum.

Doses. Dog. grs. vijss—xv; 0.5—1.0, three or four times daily.

Novatophan is a similar product but is almost tasteless. Neither of these agents is used to any extent in veterinary medicine.

Malakin is salicyl-para-phenetidin. It is a condensation product of salicylic aldehyde in para-phenetidin; occurs as fine yellow needles, insoluble in water, slightly soluble in alcohol, but freely soluble in solutions of alkali carbonates. It is an antipyretic, antineuralgic and tænifuge. *Dose.* Dog. 15 grains, several times daily.

Mesotan is methyl-oxymethyl-ester of salicylic acid which occurs as a clear yellow fluid, of aromatic odor, miscible with alcohol, ether, chloroform and fatty oils. It possesses the qualities of a volatile oil and is for external use. It is more irritant than methyl salicylate, so is diluted with an equal amount of olive oil.

Spirosal is monoglycol salicylate. It occurs as a nearly colorless, odorless, oily fluid, soluble in alcohol, ether, and chloroform and miscible with fats. It is used as the preceding drug, either in alcoholic or oily solution or as an ointment (50 per cent.).

Phenocol is most often used as the hydrochloride (amido-acet-para-phenetidin). It occurs as a white, crystalline powder, of bitter sweetish taste, soluble in water and alcohol. Used as an antipyretic and antimalarial.

Saloquinine is salicyl-quinine, occurs as a whitish, tasteless powder insoluble in water, soluble in acidulated water, chloroform and hot alcohol, sparingly soluble in cold alcohol and ether. It is an analgesic, antiperiodic, and antipyretic, analogous to quinine.

METHYLIS SALICYLAS — METHYL SALICYLATE

Synonyms. Oil of Wintergreen (Gaultheria), Oil of Sweet Birch (Betula)

Methyl Salicylate is prepared either by the distillation of the above named plants or is made synthetically. The U. S. P. requires that the label must indicate how it has been made. Its actions and uses are similar to the other salicylates with the exception that it may be used as a carminative and counterirritant.

CHAPTER X

DRUGS AFFECTING CHIEFLY THE NERVOUS SYSTEM

These agents may be classified as:

1. Those acting upon the central nervous system.
   - A. Those stimulating.
   - B. Those depressing.
2. Those acting upon the peripheral nervous system.
   - A. Those stimulating.
   - B. Those depressing.

DRUGS ACTING UPON THE CENTRAL NERVOUS SYSTEM

A. STIMULANTS TO THE CENTRAL NERVOUS SYSTEM

Those agents which stimulate the central nervous system are:

Caffeine, strychnine, atropine and cocaine. Caffeine and nux vomica or strychnine are the most important.

CAFFEINE GROUP

Caffeine is an alkaloid obtained from the coffee plant, *Coffea arabica,* or from damaged tea leaves, *Thea sinensis.* It is found in plants in widely separated parts of the world and which have no close botanical relationship. The Arabians and Egyptians used the roasted seeds of *Coffea arabica;* the Western Africans, the seeds of kola nuts; the natives of the Amazon region, guarana made by pounding the seeds, *Paullinia Cupana,* into a paste and drying this by heat; the Chinese and Japanese fermented tea leaves. In Paraguay and Uraguay, "mate" or Paraguay tea, the dried leaves and shoots of a species of *ilex* or holly were used; in North America, Appalach tea *ilex cassine.* The Mexicans and West Indians made a beverage from the fermented seeds of the chocolate plant which contain a similar alkaloid, *theobromine.*

Tea contains about 1—4 per cent., coffee 0.6—2 per cent., kola nuts 1—2 per cent., Mate 1—3 per cent. and guarana 3—6 per cent. That obtained from tea was formerly called theine.

Preparations and Doses.

Caffeina, caffeine is a white powder. One gram dissolves in 16 mils of water and 66 mils of alcohol.

Doses. H. gr. xv—xxx; 1.—2. D. gr. j—vij; 0.06—0.5.

Caffeina Citrata, citrated caffeine is a mixture of caffeine and citric acid. It gives a clear syrupy solution with a small quantity of water but caffeine precipitates on dilution, then redissolves on further dilution.

Doses. About twice those of caffeine. It is not suitable for hypodermic administration.

Caffeina Citrata Effervescens, effervescent caffeine citrate is an effervescent preparation. It is not used to any extent in veterinary medicine. The doses would be about the same as for citrated caffeine.

Caffeinæ Sodio-Benzoata, Caffeine-Sodium-Benzoate is a mixture of caffeine and sodium benzoate. It contains when dried to constant weight not less than 46 nor more than 50 per cent. of anhydrous caffeine, the remainder being sodium benzoate. It occurs as a white odorless powder with a slightly bitter taste. One gram dissolves in 1.1 mils of water; some caffeine separates on standing and in 30 mils of alcohol. It may be used hypodermically.

Doses. H. 3j—ijss; 4—10. D. grs. jss—xxx; 0.1—2.

Caffeinæ Sodio-Salicylas N. F. contains about 60 per cent. of caffeine. The doses are the same as for the preceding salt. It may also be used subcutaneously.

Action, Digestive System. Caffeine slightly stimulates peristalsis, increases the appetite in man, is a mild chologogue and laxative but is not used for these actions.

Circulatory System. The characteristic actions of therapeutic doses of caffeine are to accelerate the heart, increase its force and raise blood pressure. The increased rate and force are due to direct action on the cardiac muscle, while the blood pressure is raised on account of the increased efficiency of the heart and constriction of the blood-vessels through stimulation of the vasomotor center. On the other hand, in some cases the rate of the heart is diminished and blood pressure lowered on account of a tendency to stimulate the inhibitory center in the medulla and dilatation of some of the peripheral vessels through action upon the plain muscle of their walls. After very large or toxic doses, the heart beats so rapidly that the ventricles do not have time to fill, delirium cordis takes place and the organ stops in diastole.

Respiratory system. Caffeine stimulates the respiratory center and increases both the number and depth of the respirations.

Nervous System. Caffeine is a true central nervous stimulant. In man the psychic functions are first stimulated, then the motor area is excited as is shown by restlessness, excitement and increase of movements. Finally the cord is stimulated as is shown by convulsions. The action upon the brain is shown in animals by increased

movements and excitement. The medullary centers are excited, causing a stimulation of the respirations and a general vasoconstriction. The cardio-inhibitory center is probably also stimulated, but this is of but little importance because the peripheral action of caffeine on cardiac muscle so overshadows its action on the center. The action upon the cord and medulla is quite similar to that of strychnine but weaker. There is the same increased reflex excitability followed by tremors and tetanus but this action follows only large doses.

Muscles. Caffeine increases the contractility of all forms of muscle. Small doses increase the contractility, strength and power for work of all muscles. After large doses the muscles become exhausted, hard, and pass into a rigor that closely resembles rigor mortis.

Kidneys. Caffeine is a decided diuretic. The water of the urine is increased to a greater extent than the solids, so that it is low in specific gravity, yet the total amount of solids eliminated is not diminished. It is generally believed that caffeine and its allies stimulate the tubules of the kidneys to an increased action and that its diuretic action is independent of the circulation. But there is another theory that caffeine dilates the vessels of the kidneys and produces diuresis in this manner. Whether the dilatation of the vessels is the cause of the increased secretion or the result of kidney activity cannot be definitely stated. At any rate caffeine and its allies act in a specific manner on the kidneys and do not cause irritation.

Metabolism. Caffeine is believed to increase metabolism. It raises temperature slightly, due no doubt to stimulation of the central nervous system and on account of increased movements.

Absorption and Elimination. Caffeine is rapidly absorbed and is chiefly eliminated by the kidneys. Some of the drug is excreted unchanged, some is changed into other compounds, but the fate of the greater part is unknown.

Therapeutics. Caffeine is not an important remedy in veterinary medicine. It may be used as *a cardiac stimulant and tonic* although it is not so efficient in valvular insufficiency as digitalis. When marked dropsy is present a combination of digitalis and caffeine may be of more service than either alone.

Diuretic. Since caffeine is a nonirritating diuretic it may be used in nephritis.

Narcotic Poisoning. Caffeine is often serviceable in cases of narcotic poisoning on account of its stimulating action on the heart, respirations and brain. Strong coffee may be used in emergency.

STIMULANTS TO THE SPINAL CORD — EXCITOMOTORS

These drugs increase the functional activity of the spinal cord, exaggerate reflex activity and in large doses produce tetanic convulsions by stimulating the cell bodies of the lower motor neurons. Whether the convulsions are of spinal or cerebral origin can be proven by division of the cord between the atlas and occiput. Those of cerebral origin cease after such a division, while those of spinal origin do not. The most important members of the group are:

Strychnine	Caffeine
Brucine	Ammonium salts
Hydrastis	Phenol

Of these only the first two are of importance from their therapeutic effect.

NUX VOMICA, NUX VOMICA

Synonyms. Dog Button, Quaker Button, Poison Nut

Parts Used. The dried ripe seeds of *Strychnos nux vomica,* a small tree of the East Indies and yielding when assayed not less than 2.5 per cent of the alkaloids of nux vomica.

Constituents. It contains two alkaloids, Strychnine (strychnina) and Brucine (brucina). The former is in excess, is the principal one and represents quite accurately the action of the crude drug.

Preparations and Doses. All are assayed.

Fluidextractum Nucis Vomicæ. 2.5 per cent. of alkaloids. H. 3ss—ij; 2—8. D. ♏ ss—ij; .033—.13.

Nucis Vomicæ. Same as fluidextract.

Extractum Nucis Vomicæ. 16 per cent. of alkaloids of nux vomica. H. grs. vij—xv; 0.5—1. D. grs. ⅛—¼; .008—.016.

Tinctura Nucis Vomicæ. 0.1 per cent. of strychnine. 2.5 per cent. of alkaloids. H. 3v—ijss; 1.25—75. D. ♏ v—xx; .032—1.3.

Strychnine is official as strychnine (strychnina) and the following salts: Nitrate soluble in 42 parts of water and in 150 of alcohol, and the sulphate soluble in 32 parts of water and 81 of alcohol. The sulphate contains 77 per cent. of pure strychnine and the nitrate 84 per cent.

Dose of Strychnine and its salts. Horse and Cow. gr. ¼—ij; .016—0.13. Dogs. 1/200—1/40; 0.00032—0.0016. Cats. 1/200—1/65; 0.00032—0.001.

Preparations of Strychnine.

[1] *Citrate of iron and strychnine, 1 per cent. Dose.* D. gr. ss—ij.

[1] *Elixir of the phosphates of iron, quinine and strychnine.* 1 dr. (4 mils) = 1/65 grain (0.001 gm.) strychnine and 7/13 grain quinine.

[1] *Syrup of the phosphates of iron, quinine and strychnine.* 1 dr. (4 mils) = 1/80 gr. (0.0008 gm.) strychnine and 1 3/5 grains quinine.

[1] *Glycerite of the phosphates of iron, quinine and strychnine.* This is four times the strength of the syrup, for the preparation of which it is used.

[1] *Compound syrup of the hypophosphites,* 2 drams (8 mils) contains 1/70 grain (0.001 gm.) of strychnine and 2/15 grain of quinine.

[1] *Compound laxative pills,* aloin 1/5 gr., extract belladonna 1/8 grain, ipecac 1/6 grain, strychnine (the alkaloid) 1/120 grain (0.0005 gm.).

External and Local Action. Strychnine is an antiseptic in strong solution but is too dangerous to use.

Digestive System. Strychnine or nux vomica is an excellent stomachic tonic, improving the appetite and aiding digestion. Strychnine reflexly stimulates the flow of saliva and gastric juice by acting as a bitter. It increases peristalsis by imparting tone to the muscles of the intestines by action through the cord and consequently relieves constipation due to lack of tone. For the action upon digestion some preparation of the crude drug should be used, partly because it is not absorbed so rapidly and partly because it may contain other valuable bitter principles. It is usually combined with mild purgatives for its action on peristalsis.

Nervous System.

1. *Cerebrum.* There is a slight stimulation of the intellect and of the motor areas, but strychnine is not a pronounced intellectual stimulant. The special senses are all stimulated. Consciousness is retained until asphyxia coma sets in.

2. *Spinal cord.* The first symptom of the use of the drug is an increase in the spinal reflexes. Even slight stimulation under the influence of strychnine is sufficient to throw the whole body into a clonic convulsion which is characterized by sudden contractions of all striped muscles of the body, lasting for a few seconds or minutes and followed by complete relaxation, with all signs of paralysis. After a brief interval, the spasms are repeated and again followed by paralysis. They may be started by any external stimuli, such as touching the animal, clapping hands, talking, etc. That the convulsions are of spinal origin can be demonstrated by the elimination of other factors which might cause convulsions. The cord has no power, under the influence of strychnine, to originate new impulses but intensifies the ordinary impulses by facilitating their passage through the sensory paths, so that slight stimulation leads to exagger-

[1] Unofficial.

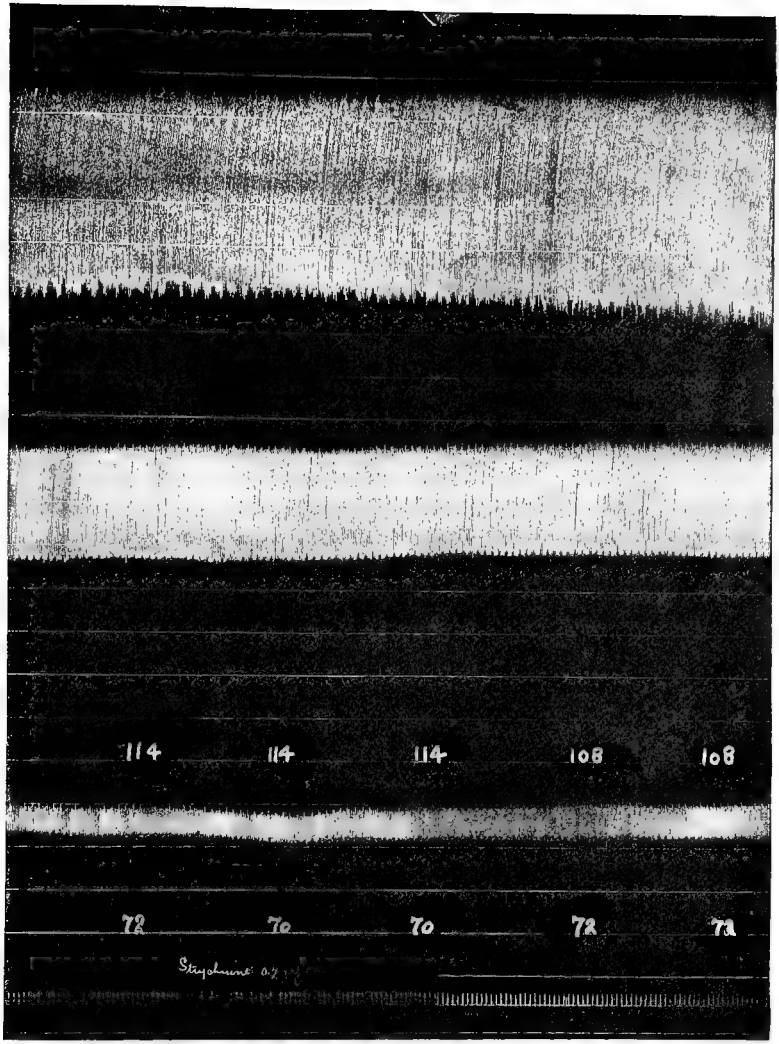

FIG. 16.—Strychnine sulphate, 0.2 mg. per kilo, no effect on circulatory organs. Upper tracing, auricle; middle, ventricle; lower, blood-pressure; upper line of figures, pulse-rate. (Tracing made by Dr. C. C. Lieb.)

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ated motor response. Strychnine tetanus should be conceived as caused by the extensive spreading of reflexes on the application of normal stimuli. This spreading is not normally present except after the strongest stimuli.

Medullary centers. The centers in the medulla are first stimulated, then depressed and finally paralyzed. This paralysis may be obscured for a short time by the convulsions, but shows in the intermissions between the convulsions in the later stages of poisoning; and is the usual cause of death, unless the animal dies during a respiratory spasm from asphyxia. Those factors concerned in the death of the animal usually fail in the following order: Respiratory center, vasomotor center, vagus center and cardiac muscle.

Respiratory System. The respiratory center is stimulated both directly and indirectly by increased muscular effort causing the respirations to be quickened and deepened, while large or toxic doses quickly exhaust the center. Death takes place from asphyxia, due either to tetanic contraction of the respiratory muscles during a convulsion, or to exhaustion of the center between the convulsions.

Circulatory System. Medicinal doses raise blood pressure and slightly slow the heart. The former is due to vasoconstriction by stimulation of the vasomotor center and the latter, to stimulation of the vagus center. Frequently no result is seen. There is no action on the heart in therapeutic doses, probably not in toxic ones, and strychnine is not a cardiac stimulant in the truest sense of the word. Clinicians, however, quite generally assert that it is a cardiac stimulant. This does not necessarily mean that it has any direct action on the heart but that the pulse is improved. The improvement in the condition of the pulse is probably due to an increased blood pressure. Toxic doses at first cause a great increase in blood pressure due to stimulation of the vasomotor center, but this stimulation is followed by depression and the pressure falls.

Special Senses. All the special senses appear more sensitive under influence of strychnine. Vision, hearing, and sound seem to be more acute.

Muscle. The tone of all muscle is improved. There is no direct action upon muscle, but there may be increased muscular power, resulting from an increased reflex excitability together with improvement of tone.

Absorption and Elimination. Strychnine is rapidly absorbed especially from the intestines and begins to be eliminated quite quickly by the kidneys. Some is oxidized in the body and the remainder is excreted in the urine. It can be found in the urine within a few minutes after administration and most is excreted in a few hours, although traces may be present for four or five days. Cumulative action may take place if the drug is pushed to its limit for some time, but is of rare occurrence. In strychnine poisoning,

the urine after concentration by boiling will produce characteristic convulsions if injected into a frog.

Temperature. The temperature is slightly raised by therapeutic doses on account of increased oxidation. During the tetanic convulsions it is much elevated but falls in the exhaustive or paralytic stage just before death.

Toxicology. The early symptoms of strychnine poisoning are uneasiness, nervousness, restlessness, anxiety, twitching of the muscles and stiffness of the neck. If the dose is sufficiently large the twitching increases and spinal convulsions quickly appear. The body is thrown in orthotonus or opisthotonus. The convulsions are usually intermittent with a period of depression but can be excited by the slightest external stimuli such as talking, touching, clapping the hands, etc. The pupils are dilated, the mind clear and the animal suffers severe pain. In fatal cases the convulsions follow each other rapidly with increasing severity and finally death takes place from asphyxia, spasm of the respiratory muscles, exhaustion, or paralysis of the medullary centers. Very large doses may kill by paralysis of the central nervous system or motor nerve endings.

Diagnosis of Strychnine Poisoning. *From tetanus* by absence of history of a wound or presence of a wound, intermittent character of convulsions, late involvement of the muscles of the jaw, and rapid course.

From eclampsia of nursing bitches. In eclampsia the reflex excitability is not increased.

Treatment. 1. Keep the animal and surroundings as quiet as possible, as very slight stimuli will cause convulsions.

2. Use emetics or stomach tube if convulsions have not already appeared. If they have started these should not be attempted as convulsions will be caused by their administration. In this case, control the convulsions first with chloroform, chloral, amyl nitrite, paraldehyde, etc.

3. The chemical antidotes are tannic acid and potassium permanganate, but these should be washed out of the stomach as soon as the condition of the patient permits.

4. The physiological antidotes are chloroform, ether, chloral hydrate, paraldehyde. For quick action chloroform or ether can be given by inhalation (by artificial respiration if necessary). Chloroform may be used to check the spasm but should then be replaced by ether to hold the condition. When the convulsions have been controlled, chloral hydrate or paraldehyde may be given per rectum. The bromides, in large doses, are recommended in human practice for lasting effect. Morphine should not be used because it not only fails to antagonize strychnine on the cord, but is at the same time depressant to the respiratory center.

Therapeutics.

1. *Stimulant to digestive apparatus and general tonic.* The tonic effect of the drug may be explained in two ways. A. By increasing the muscular tone, which in turn produces a more healthy feeling in the animal. B. Its effect upon the digestive tract improves digestion and increases the appetite. It is especially valuable to stimulate the digestion, increase the appetite and stimulate peristalsis in acute diseases. Combined with iron and arsenic it is one of the most satisfactory tonics for veterinary patients, particularly when the digestive system is deranged. It is especially valuable in atonic forms of indigestion and constipation associated with anemia. It is also valuable in overloaded rumen of cattle, and impacted large intestines of horses. The best results in these cases are probably obtained by its hypodermic use along with a rapid purgative. Constipation and diarrhea are benefited when either is due to atony of the bowels.

2. *As an excitomotor,* it is the best agent for paralysis due to depression or exhaustion of the nervous mechanism but is absolutely valueless in cases due to organic lesions, or in other words in cases where there is a complete destruction of the nerve elements. That is, it is especially useful in functional disorders or lowered activity of the cord which follow as sequellæ of other diseases, such as influenza of horses or distemper of dogs. In mild cases of chorea in dogs it may be combined with Fowler's Solution of Arsenic. Strychnine is also useful in paralysis following lead poisoning, or toxemia, or in cases of paralysis of peripheral nerves (facial, superscapular) from traumatism, but should not be used until inflammation has subsided.

3. *Respiratory Stimulant.* Since strychnine is a circulatory as well as repiratory stimulant it is indicated in diseases of the respiratory tract associated with weak pulse and feeble respiration, such as pneumonia, emphysema, and some cases of chronic bronchitis. It is also useful in cases of poisoning by depressant drugs such as opium, chloroform, etc. In these cases it should be given subcutaneously in full doses.

4. *Circulatory Stimulant.* It is inferior to digitalis in simple dilatation of the heart with or without valvular disease but may be useful combined with it. It is of much value in pneumonia as an adjuvant to digitalis and alcohol. It is useful in surgical shock and is superior in the weak heart of the aged.

HYDRASTIS

Synonym. Golden Seal

Parts Used. The dried roots and rhizomes of *Hydrastis Canadenis,* yielding when assayed not less than 2.5 per cent. of Hydrastine.

Constituents. Hydrastis contains *hydrastine,* colorless and slightly bitter, *berberine,* yellow and very bitter; *canadin* in small amounts and *hydrastinine,* an artificial alkaloid having a marked effect upon blood pressure. The action of the drug is represented by hydrastine. Berberine is but a simple bitter in ordinary doses but depresses the vasomotor center in large doses and lowers blood pressure. Canadin has a morphine-like action but exists in too small amounts to be of any therapeutic importance.

Preparations and Doses.

Tinctura Hydrastis. H. ℥j—ij; 30—60. D. ʒss—ij; 2—8.

Fluidextractum Hydrastis. H. ʒij—viij; 8.—30. D. ♏ v—lx; .032—4.

**Fluid Hydrastis.* For application only.

Glyceritum Hydrastis. For application only. 100 per cent. Hydrastis.

Hydrastine, a variable mixture. H. grs. xv—xxx; 1.—2. D. gr. ⅕—½; 0.010—0.03.

Hydrastininæ Hydrochloridium. H. gr. j—ij; 0.065—0.13. D. gr. 1/12—½; 0.005—0.03.

Externally and Locally. Hydrastis has a slight astringent action and is therefore employed as a stimulant to mucous membranes in chronic catarrhal conditions.

Nervous System. Moderate doses resemble the action of strychnine in many respects, particularly upon the cord. The cord is stimulated, reflexes increased with tonic and clonic convulsions, but the paralytic stage is more prominent.

Digestive System. It has the action of a bitter upon the appetite. It stimulates the secretion and motion of the stomach and increases peristalsis in the intestines. Large doses produce vomiting and diarrhea.

Respiratory System. In ordinary doses the respiratory center is stimulated; but in poisoning it is depressed, and death takes place from asphyxia due to paralysis of the respiratory center or to convulsions, very similar to the case in strychnine poisoning.

Circulatory System. Large doses stimulate the vasomotor center, constrict the arterioles and raise blood pressure. This action is soon followed by a lowered blood pressure, due to depression of the above center and the heart. There is so much contradictory evidence relative to the action of the drug upon the circulation that it seems best to say that medicinal doses produce a short and weak rise in blood pressure if any at all, and that this is soon followed by a depression as explained above.

Uterus. Hydrastine is a feeble oxytoxic, acting similarly to, but less active than, ergot.

Toxicology. The symptoms are about the same as those in strychnine poisoning and the treatment the same as for strychnine.

Therapeutics.

1. *Bitter stomachic* in anorexia, convalescence or wherever a bitter is desired.
2. *Excitomotor.* It is inferior to strychnine in every respect for action on the cord.
3. *Catarrhal conditions.* There seems to be some good inflence in inflammations of the mucosa, especially that of the genito-urinary tract, although the manner of action is not known. The glycerite, fluid or hydrastine in solution are used for this purpose.

HYDRASTININAE HYDROCHLORIDUM
HYDRASTININE CHLORIDE

Dose. See above.

It is freely soluble in water and alcohol. Hydrastinine has the same action on the centers as hydrastine but in addition has a local constricting action on the arteries. Furthermore, it is depressant to the heart and other muscles. It produces a rise of blood pressure by stimulating the vasomotor center. It is used for its action upon the uterus, as it stops uterine hemorrhage by cutting down the blood supply through constriction of the arterioles, and to some slight extent by stimulating the uterus itself. A 10 per cent. solution has been used in treating hemorrhage from the nose, mouth, etc.

Cotarnin Chloride (Stypticin) is not official. Chemically it is oxymethyl hydrastine.

Dose for dog, ½ grain. (0.03.)

This is prepared from narcotine, and strongly resembles hydrastinine, but with a hydrastine tendency to depress the heart.

B. DEPRESSANTS TO CENTRAL NERVOUS SYSTEM

CEREBRAL DEPRESSANTS

Cerebral depressants may be classified as hypnotics, general anesthetics, general analgesics, and anticonvulsants. Hypnotics, somnifacients or soporifics are agents which produce sleep. If they depress the psychic areas aside from their hypnotic effect they are termed narcotics. The following factors favor sleep:

1. Removal of external stimuli.
2. Fatigue of the brain cells, making them less responsive to external influences.
3. Accumulation of waste products in the blood which are given off by the cells while producing energy.

4. Lessening the blood supply to the brain.
5. Depression of the brain cells by drugs.

Somnifacients are of but little if any use in veterinary medicine as such, since we do not have to deal with insomnia of animals. They are valuable, however, to relieve pain, spasm, produce mild degree of anesthesia or dullness and for their other valuable side actions.

General Anesthetics are drugs which when inhaled produce unconsciousness and insensibility. They have a more profound effect upon the brain than the hypnotics in that they temporarily inhibit the responsiveness of the cells to external stimuli and to a certain extent suspend their power to recuperate. On the other hand, the somnifacients inhibit the functional activity of the brain cells but do not completely suspend their recuperative powers (the main object of sleep) nor the power to react to external stimuli.

General Analgesics or Anodynes are agents or remedies which relieve pain. They are sometimes classified as a division of hypnotics which are especially active in relieving pain. They may produce their action by directly depressing the receptive centers in the brain or by preventing the passage of painful impressions through the sensory nerves and spinal cord to the brain.

Anticonvulsants are remedies which check excessive motor activities. In cerebral convulsions they may act

(1) By directly depressing the cells of the cortex of the brain.

(2) By preventing the transmission of external stimuli to the brain, through depressing the sensory side of the brain and spinal cord.

(3) By preventing the transmission of painful impulses from the brain to the muscles, by depressing the motor side of the spinal cord and peripheral nerves.

GROUP OF HYPNOTICS

The most important members of this group in their order are:

Opium	Bromides	Sulphonal
Chloral Hydrate	Chloretone	Hedonal
Cannabis	Urethane	Veronal
Hyoscine	Paraldehyde	

OPIUM

Opium is the concrete juice or milky exudate obtained by incising the unripe capsules of *Papaver somniferum,* and yielding, in its normal moist condition, not less than 9.5 per cent. of anhydrous morphine. It is simply the dried milk-juice which exudes from encircling incisions made in the green capsules of the common poppy plant of oriental countries. This plant is indigenous to Asia and

has been cultivated in many other lands. The only opium meeting the U. S. P. requirements is that from Asia Minor, and known as Turkish or Smyrna opium.

Constituents. Opium contains some eighteen or nineteen alkaloids together with meconic acid and meconin, a neutral principle. The most important alkaloids in order are: morphine, codeine, heroin (diacetyl morphine), dionin, thebaine, papaverine, narcotine, and narcine. Morphine is the most important and with few exceptions represents the action of the crude drug.

Preparations and Doses.

Tinctura Opii (*Laudanum*), 10 per cent. opium, 1 per cent. morphine. H. ℥ss—ij; 15.—60. D. ♏ iij—xx; 0.2—1.3.

Tinctura Opii Camphorata. Paregoric (Camphorated tincture of opium). 4 grams of powdered opium to 1000 mils. Used for dogs only. D. 3ss—iv; 4.—15.

**Tinctura Opii Deodorata,* 10 per cent. of opium. *Dose* same as for tincture.

Extractum Opii (20 per cent. morphine). H. 3ss—j; 2.—4. D. gr. ⅓—½; 0.2—0.1.

Opium (crude drug) 9.5 per cent. morphine. H. 3j—ij; 4.—8. D. gr. ½—iij; 0.03—0.2.

Powdered Opium (12—12.5 per cent. morphine). One-third less than of crude drug.

Deodorized Opium. Same strength as the powdered drug, but with narcotine and certain disagreeable odorous principles removed by benzine. *Doses.* Same as for powdered drug.

Pulvis Ipecacuanhæ et Opii. Dover's powder. 10 per cent. of powdered opium and ipecac and 80 per cent. of sugar of milk. H. ℥ss—j; 15.—30. D. grs. iij—xv; 0.2—1.

**Tincture of Ipecac and Opium,* 10 per cent. of each. *Dose.* Same as for Dover's powder.

**Lead and Opium wash* (Lotio Plumbi et Opii N. F.) is made by adding 35 mils of tincture of opium to 17.5 gms. of lead acetate dissolved in 650 mils of water and then adding enough water to make 1000 mils.

Preparations of the alkaloids:

MORPHINA — MORPHINE

This may be purchased in several salts. Morphine and morphine acetate are not readily soluble in water, the hydrochloride is soluble in 17.5 parts of water and 52 parts of alcohol; and the sulphate in 15.5 of water and 240 parts of alcohol.

[1] Unofficial.

Doses. Horse. grs. ij—v; 0.13—0.3. Dog. gr. ⅕—v; 0.013—0.3.

**Compound Morphine Powder* (Tully Powder) contains 1.5 per cent. of morphine sulphate, with camphor, licorice and chalk.

Magendie's Solution of Morphine, Liquor Morphinæ Hypodermaticus, N. F. It is of the strength of 1—30, in distilled water, with the addition of a small amount of salicylic acid as a preservative. Five minims of the solution contain ⅙ grain of the sulphate, or each mil contains about ½ grain. *See prescriptions following* page 147. This preparation slowly weakens and acquires a brown color.

**Pantopon* is said to contain the alkaloids of opium in the same proportion in which they exist in opium itself. The dose is twice that of morphine.

**Pleistopon* is a similar product with the narcotine removed.

Opium and its alkaloids are incompatible with iron, mercury, zinc and the alkalies.

External and Local Action. Morphine and opium have no local action. Their action to overcome pain is purely central and since they must be absorbed and reach the centers before they can check pain, they have no more power for this action when applied locally than when given by mouth. Furthermore, pain is relieved in distant parts of the body just as much as at the point of application. Hence, the use of opium or its preparations as dusting powders, washes, suppositories, etc., is not only irrational but has the additional disadvantage of being uncertain of absorption.

Digestive System. The principal actions of opium and morphine on the digestive tract are to diminish secretions and peristalsis, cause nausea and vomiting. Nausea and vomiting almost invariably follow the use of morphine in any form in moderate or large doses in the dog and cat, and since this action is very quickly produced by subcutaneous injection it would appear to be of central action. Riegel found in dog and man that the secretion of the gastric juice was first retarded but is subsequently increased beyond the normal. The effects in the intestines vary with the doses used and the species of animal. Small doses diminish peristalsis in all animals, but large ones produce active or violent peristalsis and frequent evacuation of the bowel in the dog and cat. The intestinal secretions are somewhat diminished but the constipation which follows morphine and opium is largely due to the slow emptying of the stomach, together with the slow passage of the intestinal contents due to the lessened peristalsis. The total result of the diminished peristalsis and secretions is that digestion is delayed, appetite appeased and constipation almost always follows.

* Unofficial.

Circulatory System. There is practically no direct action on the circulation, although the heart may be accelerated for a short time by stimulation of the heart muscle or from the nausea produced. Large doses slow the heart by stimulation of the vagus, but on account of the action upon the vasomotor center, blood pressure does not fall. There is no effect upon the peripheral vessels except those of the skin, which are dilated even by small doses. This is especially so of the vessels of the skin of the head and neck in man. The dilatation of the skin vessels gives a sense of warmth to the skin and causes an increase in the secretion of sweat.

Toxic doses of opium produce a rapid weak pulse and depress all the functions so that the blood pressure falls; the skin becomes pale, due to withdrawal of the blood to the splanchnic vessels, and on account of asphyxia from depressed respirations.

Nervous System. In mammals opium produces depression of the voluntary movements and later an increase in the reflex irritability, but the relative importance of these two stages differs in the different species of animals and even in different individuals of the same species. For instance, in the members of the cat family and the horse, cow, sheep and pig, morphine rather seems to increase movement. The animals run about the room, or make circus movements and are very restless. At the same time there is a depression of the intelligence and of power of perception because they make no effort to escape and do not avoid obstacles so carefully as normal animals. Convulsions finally set in, similar to those in strychnine poisoning. On the other hand, the depressant action is more pronounced in the dog. After small or fair sized doses, these animals pass into sleep, from which they can be easily wakened at first, but this soon deepens so that it requires greater force to waken them. After being aroused, the dog appears to sleep less soundly, and less stimulation will awaken him if applied within a short time afterwards. During the awakening period the animal may appear to perform voluntary movements, but there is a lack of coordination, partial paralysis of the hind extremities and lack of consciousness. He is drowsy and stupid and soon sinks back into a deep sleep. The sensation of pain seems to be much diminished, but not entirely so, as the dog will often wake from severe sudden pain. The reflexes at this time are much depressed. "After larger doses," according to Cushny, "an exaggerated sensibility to external stimulation seems present, for the animal starts convulsively on loud sounds and on pinching, but when undisturbed lies in a profound sleep."

The stage of strychnine like convulsions as mentioned in case of the cat is not seen in the dog after morphine, although the reflex irritability may be distinctly increased by large doses.

From the above symptoms it would seem that the action upon the central nervous system consists of a mixture of stimulation

and depression which is not equally marked, however, throughout the divisions of the central axis. Cushny says concerning this, "The depression seems to be produced mainly in the brain, especially in those parts associated with the higher intellectual faculties, while the stimulation affects first the spinal cord. It seems likely that in different animals these two opposing influences prevail to varying extents, so that in some the stimulant action extends to the brain, as in the cat, while in man the depressant action dominates the whole central nervous system, at any rate when moderate quantities are used. The action on the brain is elicited by smaller quantities than that on the cord, so that the first effect of morphine is intellectual depression, while the increased activity of the spinal functions is only elicited by very large quantities. The selective action of morphine is especially evident in the medulla oblongata, in which certain centers are entirely paralyzed before neighboring ones undergo any distinct modification."

The action of morphine has been studied almost entirely upon the frog and in this animal the reflexes are first diminished and then heightened as in case of strychnine poisoning. This action is seen to some extent in young animals (increased reflexes) but tetanic convulsions are not seen in mammals. There is no good theory to explain the action of the drug upon the different animals. Small doses usually cause drowsiness in horses but larger ones are liable to cause excitement. Opium and morphine are among the most powerful and reliable analgesics in man but cannot be depended upon for this action in the lower animals, with the exception of the dog.

To sum up the action on the nervous system we would say that morphine depresses all the nerve cells in the brain, and very slightly the motor cells. In the cord there is at first a similar depression which may be followed by some hyper-excitability, as shown by twitching, tremors, etc.

Peripheral Nerves. Morphine has no effect upon either the motor or sensory nerve endings so that its local use is irrational. It is frequently used to check cough and accomplishes this action by reducing reflex irritation or depression of the respiratory center.

Secretions. The secretory glands, in general, appear to be less active under the influence of morphine. If nausea is caused, there is an increase in the secretion of saliva and mucus but this is due to the nausea and not to any direct influence upon the glands themselves. The sweat glands are exceptions to this general statement, for slight diaphoresis is usually seen from therapeutic doses. There is no influence upon the urine.

Respiratory System. In most animals the respirations are depressed by therapeutic doses, due to depression of the respiratory center, but in the dog there may be panting in the early stages,

probably due to the emetic and purgative action. The respirations are somewhat deeper than normal but they are so much slowed that there is a decrease in the amount of respired air per unit of time. In the later stages of poisoning, the respiration may become shallower and irregular. The irregularity may be intermittent, a series of deep inspirations being followed by a series of shallow ones, and then by complete suspension for a few seconds. The breathing then commences with slight movements, followed by a series of increasing regularity in strength and then again decreasing. (Cheyne-Stokes respiration.) In fatal cases, the respirations become slower, shallower and finally cease.

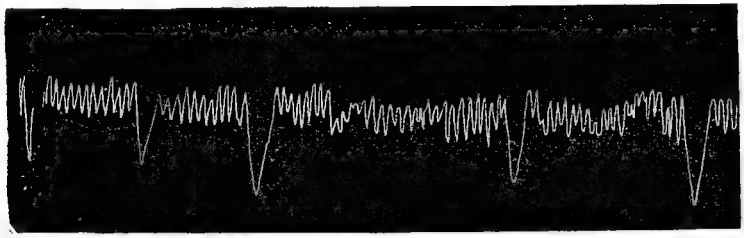

FIG. 17.—Dog. Cheyne-Stokes respiration after a large dose of morphine. Down-stroke inspiration.

Temperature. The temperature often falls slightly under the influence of morphine, due probably to less active movements and dilatation of the cutaneous glands and sweating.

Eye. In man the pupils contract and in fatal cases so much so that there is the pin hole pupil until just before the final asphyxia when it dilates widely. In the dog there is the same effect, but in animals in which there is increased movement and excitement the pupils are dilated. This action is probably central, since morphine does not cause this action from local application.

Absorption and Elimination. Morphine and opium are rapidly absorbed. Morphine is excreted very largely by the digestive tract, in the saliva, stomach and bowels. It has been found in the mouth in two and one-half minutes after hypodermic injections, and in the stomach in three minutes. In dogs about 30 per cent. of the hypodermic doses can be recovered from the stomach, a fact which shows the necessity of washing the stomach in cases of poisoning. From 30 per cent. to 40 per cent. more can be recovered from the feces. This makes it very evident that there must be a considerable amount of reabsorption and reexcretion of the drug in the digestive tract with the final destruction of the morphine or its evacuation with the feces. It is also eliminated to some extent by the sweat, urine and milk; and some authors say that sufficient is excreted by the last named channel to be dangerous to the young.

Metabolism. The excretion of carbonic acid is diminished during the depressant stage but in animals in which excitement is produced, it may be increased due to increased muscular movement. There may be an increase of lactic acid in the blood and urine and a disappearance of glycogen from the liver on account of the poor respiration.

Treatment of Poisoning. Evacuate the stomach with the stomach tube or stimulating emetics such as sulphate of zinc or copper, or mustard, but on account of the depressant action of the nervous system, emetics are uncertain and the stomach tube is to be preferred. The stomach should be evacuated at frequent intervals to remove the drug as it is excreted into this organ. Potassium permanganate should be administered at intervals to oxidize the drug for the same reason. The above measures hold good no matter how the morphine may have been administered, as it is eliminated by the stomach in large amounts. Maintain the respiratory and circulatory systems with stimulants, of which caffeine appears to be one of the best. Atropine was considered at one time to be antidotal, but must be used in very small doses for this action because large doses are in themselves depressant to the respiratory center. They may, furthermore, cause serious constipation as mentioned under discussion of the action upon the digestive tract. The animal should be kept awake by exercise, dashing of cold water upon it, etc. Artificial respiration should be used if the respirations cease before the heart stops beating.

Contraindications. Young animals are quite susceptible to morphine and opium so that considerable care should be used in prescribing for them. Morphine is not indicated in respiratory diseases associated with excessive exudation, in cerebritis, high fever, or constipation.

Therapeutics. Morphine and opium are used to relieve pain, overcome nervousness and excitability, lessen reflex excitability, diminish secretions, support the system and as diaphoretics.

Pain. Opium is not of so much service to relieve pain and spasm in veterinary medicine as in human therapeutics because it cannot be relied upon in any animal except the dog. Small doses, however, are usually sedative to the horse so that the drug is especially indicated in strong persistent pain such as in enteritis. It may often be extremely useful in spasmodic colic and produces its action here by arresting the irregular and violent peristalsis which is the cause of the pain. It may be combined with small doses of atropine or belladonna for this purpose.

To Check Peristalsis. Opium is very serviceable for this purpose in various intestinal troubles, especially acute intestinal catarrh and diarrhea. By checking both peristalsis and secretions, an opportunity is given for a chance of repair, and permanent cure.

It is also very serviceable in peritonitis, both for its analgesic effect and because it checks peristalsis which causes the pain. Opium is preferable to morphine for this action because it lies longer in the bowel, and therefore evolves a stronger action there than on other parts of the body and also because the other alkaloids have some constipating effect. In septic diarrhea it is to be avoided. There are several popular remedies for this use upon the intestines, such as Sun Cholera Cure, Squibb's Compound Tincture of Opium, p. 82.

In perforation and bleeding from the bowels opium is the most efficient of all remedies, as it allows adhesions or clots to be formed by checking the movements of the intestines which would promote further leakage.

Cough. Morphine and other members of this group depress the sensibility of the respiratory center to reflex irritation and consequently check cough. One of the members of this group is especially valuable when the cough is not attended with free expectoration and is of sufficient frequency to prove distressing. But when the bronchial secretion is free, the cough is necessary to remove it and any interference with cough, results in an accumulation of fluid in the air passages, making the ultimate condition of the patient worse.

As an Introduction to General Anesthesia in Dogs. If a dose of morphine is given to dogs a few minutes before the beginning of general anesthesia, it is found that the period of excitement is much diminished and that much less anesthetic will be required. Morphine is often combined with hyoscine or hyoscine and cactin for this purpose. In larger doses either morphine or one of the preceding combinations may prove sufficient as an hypnotic or anesthetic for these animals. See Morphine scopolamine anesthesia, p. 182.

To Check Distant Hemorrhages. This action is not due to any specific action of the drug upon the bleeding surface but entirely to the fact that it produces quietness, stops movements and in this way favors the formation of a clot.

Diaphoretic. For this purpose opium is usually combined with ipecac and prescribed as Dover's powder. Although it has little diaphoretic action alone, it may enhance the diaphoretic action of ipecac by dilating the skin vessels. In the form of Dover's or Tully's powder, opium and morphine are frequently employed to produce sweating at the onset of colds, but they are not good diaphoretics.

Diabetes. Morphine, opium and codeine have a special power to bring about a reduction of the sugar excretion. Von Noorden attributes this action to quiet of the body.

Comparison of Opium and Morphine. In general the action

of morphine represents the action of opium. Furthermore, it is suitable for hypodermic use and consequently of more value when rapid action is desired. Morphine is less liable to upset the digestion than opium, but it is less useful to reduce the amount of sugar in the urine in glycosuria. Opium is to be preferred for action upon the digestive tract.

DIACETYLMORPHINA — DIACETYLMORPHINE

Synonyms. Heroina, Heroin

This is the diacetyl ester of morphine. Heroin is a proprietary preparation and much more expensive than the official drug. Diacetylmorphine occurs as a white, odorless, crystalline powder, slightly bitter and slightly alkaline in reaction. It is insoluble in water but soluble in acidulated water. The hydrochloride (diacetylmorphinæ hydrochloridum) is soluble in alcohol and water.

Doses of the Alkaloid or Its Salt.

H. gr. ½—ij; .032—.12.
D. gr. 1/24—1/12; .0026—.005.

Diacetylmorphine is not so marked a hypnotic or analgesic as morphine but has a greater tendency to increase reflex excitability. Like morphine it depresses the respiratory center and has been considered by Dreser to have a more specific action in depressing this center to reflex stimuli, as in cough, than to direct stimulation as from carbon dioxide. He also stated that it slowed the respirations but increased the force and depth of the inspirations. There is, however, a considerable reduction in the amount of air respired per unit of time. On account of its action upon the respiratory tract, Dreser believed it particularly useful in cough, but Cushny has more recently found that heroin affects the respirations, in man at least, just the same as morphine does. It seems therefore that it has no advantage over the older drug. Another advantage claimed for it is that there is less danger of producing toxic action since there is a greater difference between therapeutic and toxic doses than in case of morphine, although the actual toxic dose is not much different from that of morphine. This is because the therapeutic dose is so correspondingly small. The hydrochloride of diacetylmorphine may be given in pill, syrup, aqueous solution per os. or in aqueous solution hypodermically, but it is most often prescribed in a syrup, of which there are several upon the market.

Its chief and only use is to check cough and most impartial investigators have generally failed to obtain any better results with it than from the older drugs, morphine and codeine, and it is probably in no way superior to them.

CODEINA. CODEINE — METHYL MORPHINE

One gram of codeine dissolves in 120 mils of water and 2 mils of alcohol. One gram of codeine phosphate dissolves in 2.3 mils of water and 325 mils of alcohol. Codeine sulphate is soluble in 30 parts of water and 1280 of alcohol. Of the above preparations, the alkaloid, codeine, is the best for alcoholic solution and the phosphate for aqueous solution or hypodermic use.

Dose. H. and C. gr. iij—xxx; 0.2—2. D. gr. ¼—ij; 0.016—0.13.

Codeine is the methyl ester of morphine or methyl morphine. As a hypnotic and an algesic codeine stands between morphine and heroine, being weaker than morphine but more powerful than heroin. It is sufficiently analgesic to give good results in some cases but is not much used for this action in veterinary medicine. It differs somewhat in its action upon the nervous system from morphine, in that it produces a slight but distinct narcosis, but the sleep is not so sound or so restful as under morphine, and is occasionally followed by restlessness and excitability. If the doses are large, the short depression gives way to excitement. Codeine is less liable to cause indigestion, nausea and constipation than morphine, and is claimed to be non-habit-forming in man although there are some cases of forming the habit on record. Since it relieves bronchial irritation, and checks the secretions, it is often useful in cough. For this purpose it is often combined with an expectorant (ammonium chloride) and phenacetin or acetanilid.

ÆTHYLMORPHINAE HYDROCHLORIDUM

Synonyms. Dionin, Ethylmorphine Chloride

Ethylmorphine occurs as a white powder soluble in water and alcohol. It is much less sedative than morphine but has been used to some extent in cough and mild pain. It is analgesic in the eye, and is quite extensively used by ophthalmologists in deep-seated ocular pain. Lloyd-Owen found that there was little or no effect upon the cornea and conjunctiva after dropping a 2—5 per cent. solution in the eye, but that it was decidedly analgesic to deep-seated pain. It is not mydriatic.

Dionin is also a corneal lymphogogue, i.e., it increases the flow of lymph which is the source of nutrition to the cornea, and causes edema of the conjunctiva. This action appears quite rapidly and may last for several days but the eye becomes immune to it in about one week, so that it must be discontinued for a few days.

It is used as an analgesic for deep-seated ocular pain and to remove opacities from the cornea. It may be used in solutions of from 5 to 10 per cent. or as the powder. Dionin is rarely used internally.

The following prescriptions illustrate the use of opium and its alkaloids:

For Horses and Cattle

Anodyne.

℞ Tincturæ Opii ..... ij
Spiritus Æth. Nit. ..... ij
Olei Lini ..... O. j
M. Ft. Haustus.
Sig. Give at one dose.

Enteritis.

℞ Pulveris Opii ..... ʒ j–ij
Pulveris Camphoræ ..... ʒ j
Excipient q. s.
M. Ft. Bolus.
Sig. Give at once, repeat every 4 to 6 hours if necessary.

Astringent.

℞ Tincturæ Opii ..... ʒ iij
Tincturæ Catechu ..... ʒ v
Cretæ Preparatæ ..... ʒ iij
Aquæ q. s. .....ad. O. j
M. Ft. Solutio.
Sig. 4 ounces every 4 hours to a horse with diarrhœa.

Or Sun cholera cure.

℞ Tr. Opii.
Tr. Rhei.
Tr. Camphoræ.
Tr. Capsici.
Spts. Menthæ Piperatæ āā.
M. Ft. Solutio.
Sig. 1 ounce every two or three hours. For calves and foals, dram doses. Dogs 5 to 15 drops. Dilute well.

Cough.

℞ Syrupi Pruni Virginianæ ..... ♏ xxx
Diacetylmorphinæ Hydrochloridi ..... gr. 1/16
Ammonii Chloridi .....grs. iij
Glycerini et.
Aquæ āā. q. s. .....ad. ʒ j
M. Ft. Solutio.
Sig. Dram doses for dogs, half oz. doses for horses.

Anodyne.

℞ Tincturæ Opii ..... ♏ j–x
Aquæ ..... ʒ ij
M. Ft. Solutio.
Sig. One dose. Repeat every hour until opium effect is obtained.

Liquor Morphinæ Hyperdermaticus, N. F. (Magendie's solution of morphine).

℞ Morphinæ Sulphatis ..... 3.3 gm.; grs. xlviij
Acidi Salicylici ..... 0.1 gm.; grs. jss
Aquæ Destillatæ (warm)..... 100 mils; ʒ iij
Dissolve the morphine sulphate and the salicylic acid in the warm water and filter through absorbent cotton. When cool, pass a little distilled water through the filter to make 100 mils.

Astringent.

℞ Bismuthi Subnitratis ..... grs. v
Tinct. Opii Camph. ..... ♏ xx
Misturæ Cretæ q. s. ad..... ʒ j
M. Ft. Solutio.
Sig. Every hour.

℞ Morphinæ Sulphatis ..... gr. ¼–iij
Aquæ Destillatæ ..... ʒ j
M. Ft. Solutio.
For hypodermic injection before general anesthesia.
or
Morphinæ Sulphatis ..... gr. ¼–½
Hyoscinæ Hydrobrom ..... gr. 1/100–150
Cactini ..... gr. 1/50–1/25
Aquæ Dest. ..... ʒ j
M. Ft. Sol.

CHLORALUM HYDRATUM

Synonyms. Chloral, Chloral Hydrate

Properties. Chloral hydrate is prepared by the union of a molecule of water with trichloraldehyde (chloral), the latter being a product of the action of chlorine on alcohol. It occurs as separate rhomboidal crystals, having an aromatic, acrid, penetrating odor and bitterish caustic taste. It is slightly volatile when exposed to the air, is freely soluble in water, alcohol, ether, chloroform, and the fixed and fatty oils, and liquefies when triturated with camphor, menthol, thymol or phenol. It decomposes in strongly alkaline solutions, liberating chloroform.

Preparations and Doses.

Narcotic (H. & C. ℥ijss—iv (75—125)
(per os. or rectum.

Chloralum Hydratum

Sedative (H. & C. ℥j—ij; 30.—60.
(D. gr. v—lx; 0.3—4.

Chloral Camphor N. F. Equal parts of chloral hydrate and camphor. Used as a counterirritant.

External and Local Action. Locally it is anesthetic, antiseptic and irritant. It is especially irritant to mucous membranes and raw surfaces, so that when strong solutions are brought into contact with wounds or mucous membranes sloughing follows. On account of this action it is not suitable for hypodermic medication and even when given per os care must be taken to dilute it sufficiently so that it will not injure (burn) the throat and esophagus.

Digestive System. Small doses may be slightly sedative or anesthetic to the stomach although causing a sensation of burning in the throat, together with salivation. Large doses may irritate the stomach and cause nausea, vomiting and purging. It is also an antiferment.

Nervous System. The principal action of the drug is seen upon this system. In moderate doses it depresses the cerebrum without appreciably affecting the respiratory and circulatory systems and produces a deep sleep lasting for several hours. The narcosis is produced quite promptly and lasts for several hours without causing digestive or other disturbances. Larger doses depress all the centers, including the motor, cause deeper sleep, lessen the reflex excitability of the spinal cord and depress the respiratory and vasomotor center in the medulla. In this way it may serve as an anesthetic or narcotic for operations. It has no effect upon the peripheral nerves. Toxic doses produce all the symptoms seen in chloroform poisoning.

Respiratory System. There is no effect from moderate doses. Large doses render the respirations irregular and feeble while toxic doses paralyze the respiratory center. Death is due to respiratory paralysis.

Circulatory System. This system is not affected by small or moderate doses. Larger doses may accelerate the heart for a short time but this is soon followed by depression so that the pulse becomes slower, softer and weaker. The peripheral arteries are dilated by direct depression on the arterial muscles. Toxic doses lower the blood pressure by direct depression of the cardiac muscle, by depressing the vasomotor center and by depression of the arterial muscles.

Metabolism. The prolonged use of the drug leads to increased proteid destruction and lessened oxidation and causes fatty degeneration of the internal organs but this in much less degree than with chloroform. Hopkins (1911), in studies upon metabolism, gave dogs as much as 1.5 gm. per kilo as the daily dose, enough to produce profound narcosis and anesthesia. He found no areas of necrosis and only occasional very slight fatty changes in the liver, of the type produced by chloroform, and no changes at all in the kidneys.

Absorption and Elimination. Chloral is easily and quickly absorbed from the digestive tract, and it may be given by the mouth or rectum, the dose being the same in either case. It circulates in the blood unchanged. It is eliminated chiefly by the kidneys as the non-toxic urochloralic acid. Urine containing this acid will react to Fehling's test for reducing sugars. A small amount is eliminated by the lungs.

Temperature. Chloral hydrate is a decided antipyretic in medicinal doses and toxic doses may be followed by a dangerous reduction of temperature. The antipyretic action is probably due to dilatation of the cutaneous vessels, decreased muscular movements, and probably to depression of the heat producing center.

Toxicology. Although chloral hydrate is a powerful hypnotic, very large doses have failed to produce death. The fatal dose is said to be from 5 to 6 ounces (150.—180.0) for the horse, 2—8 drams (8.—30.) for dogs. The characteristic symptoms of acute poisoning are sleep, coma, rapid feeble pulse, slow respirations, followed by weak rapid ones, muscular relaxation and collapse. Death is due to respiratory paralysis.

Treatment. Keep the animal warm, since those kept warm artificially have been found able to withstand much larger doses than those not so protected. The respiratory and vasomotor centers, especially the former, are usually the seat of danger, and artificial respiration should be instituted when there is any sign of approaching paralysis. Caffeine should be administered since it stimulates both of the above mentioned centers. Atropine, strychnine and ammonia may be used as antidotes; atropine and ammonia, for action upon the respiratory center, and strychnine, because it stimulates those parts depressed by chloral hydrate. Active diuresis should be induced by administering hot drinks or, in emergency, warm salines or warm tap water per rectum to promote diuresis and elimination of the drug.

Therapeutics.

1. *Narcotic for Operations Upon the Horse or Cow.* It is often to be preferred to chloroform and always to morphine. It produces only a medium narcosis which is usually sufficient for most cases. One advantage of this drug is that it may be administered before casting. It causes so much depression that the casting may be

done more safely for both patient and operator. It may also be given to vicious animals before shoeing. The narcosis lasts for from one to two hours. Intraperitoneal injections were very much recommended at one time for this purpose.

2. *As a Hypnotic for all Conditions of Overexcitement.* In all spasmodic conditions, tetanus, colic, convulsions, epilepsy. It is an antidote to strychnine poisoning and may be given per rectum for this purpose, but it is not a good antidote in human practice on account of dangerous depression of the respiratory center. It may be of considerable service in certain conditions to quiet an animal and prevent undue straining as in prolapse of the rectum, vagina, or uterus. In such cases the administration of chloral hydrate will facilitate the return and retention of the part.

3. *As an Antiferment* in stomach fermentation and flatulence of the horse.

4. *Externally* it is sometimes used for its mild anesthetic and antiseptic properties to relieve pruritis.

5. *Chloral-camphor* is sometimes used as a counterirritant in human medicine but has no particular place in veterinary practice.

Administration. Chloral hydrate may be given per os, in capsule, or solution. Careful attention must be taken in the first case that the animal does not chew the capsule, since serious burning of the throat and esophagus will result. In the last case, it should be well diluted or administered in mucilaginous drink. It may also be injected per rectum or intra-peritoneally, in solution in water.

℞ Chlorali Hydrati ..... ℥ ij
Acaciæ ..... ℥ j
Aquæ q. s. .....ad. O. vj
M. Ft. Sol.
Sig. At one dose per rectum as narcotic for horse.

℞ Chlorali Hydrati ..... gr. lx
Acaciæ ..... gr. xxx
Aquæ q. s. .....ad. ℥ viij
M. Ft. Sol.
Sig. At one dose per rectum for a dog with strychnine poisoning.

℞ Chlorali Hydrati ..... ℥ j
Aquæ q. s. .....ad. O. ij
Sig. One dose for cow with prolapse of uterus.

OTHER HYPNOTICS OF THIS GROUP

* **Butyl-Chloral Hydrate** (Croton Chloral Hydrate) is an oily liquid formed by the action of chlorine on acetic acid. It is converted into the solid Butyl-Chloral Hydrate by the addition of water. Butyl-Chloral Hydrate occurs as white, pearly scales, with a pungent

* Unofficial.

odor and disagreeable acid taste. Its hypnotic action is very strong but of short duration. In general the action of this drug resembles that of chloral hydrate but it is less irritating to the stomach. It is recommended as especially serviceable in trifacial neuralgia of man. It is of no importance in veterinary medicine.

* **Chloretone** (chlor-butanol or chloroform acetone) is a compound formed by the addition of caustic potash to equal weights of chloroform and acetone. It occurs as a crystalline powder of a camphoraceous odor, is sparingly soluble in cold water, freely so in hot water, alcohol, ether, glycerin and the fixed and volatile oils. It is used mainly as a hypnotic, local anesthetic, and preservative. Its use as a hypnotic is almost entirely confined to laboratory animals. Results are produced promptly and are very persistent, but it is not suitable for work where it is desired that the animal recover. It may be used as an antiseptic and anesthetic dusting powder on wounds and as a preservative for certain solutions of organic composition as adrenaline, cocaine.

Paraldehyde is formed by treating aldehyde with dilute nitric or sulphuric acid. It occurs as a colorless, volatile liquid with a strong etherial odor and disagreeable pungent taste. It resembles chloral in action but is not so depressant to the heart. Large doses are apt to disturb digestion. The uses are similar to those of chloral. Locally, it resembles ether and by its irritation of the mouth and probably also of the stomach is a reflex respiratory and circulatory stimulant. It is rapidly absorbed and soon produces sleep without any appreciable disturbance of the medullary centers. Its chief disadvantages are its unpleasant taste, irritant local effects and persistence of odor and taste. It may be given in water or sweetened water. It may also be given per rectum dissolved in water. It is relatively non toxic. Noël and Soutter (1913) recommended it for intravenous anesthesia in man used as follows: From 5 to 15 mils each of paraldehyde and ether are dissolved in 150 mils of 1 per cent. saline infusion and injected at the rate of 5 to 10 mils per minute. This produces a mild narcosis at once and deep anesthesia in one minute, which ceases after stopping the infusion. The anesthesia is followed by easy recovery or sleep.

* **Amylene Hydrate** (dimethyl-ethyl-carbinol) a light, colorless, oily fluid soluble in 10 parts of water. It has a similar but weaker hypnotic action than paraldehyde. Its odor and taste are also less disagreeable.

* **Dormiol** (amylene-chloral) is a compound of amylene with chloral which has been recommended as a hypnotic. It is a colorless, oily liquid, of a camphoraceous odor, and cooling taste; soluble very slowly but freely in hot water; miscible in all proportions in alcohol, ether, chloroform and fatty oils.

* Unofficial.

* **Chloralformamidum** (chloralamide) is a compound of chloral and formamide which splits into its constituents in the blood. It occurs as colorless, lustrous crystals, without odor, and having a somewhat bitter taste. Soluble in 18.7 parts of water, and in 1.3 parts of alcohol. Readily soluble in ether, glycerin, acetone, and acetic ether. Its hypnotic action is due to the chloral but it is believed that the formamide renders it less dangerous to the heart and vasoconstrictor center.

Sulphonmethanum Sulphonal, *sulphonethylmethanum* Trional and *diethysulphonediethymethane* Tetronal are compounds of ethyl with sulphur (sulphones) and differ from each other only in containing two, three and four molecules of ethyl respectively. They are crystalline bodies, not very soluble in water. They have been introduced as substitutes for chloral hydrate but are of no importance in veterinary medicine. Average dose for dogs, 12 grains (0.75).

* **Veronal** (diethymalonylurea or diethyl-barbituric acid) occurs as a white, crystalline, odorless, slightly bitter powder, slightly soluble in water, more readily so in alcohol. The action is similar to trional. It usually causes sleep in man, which results promptly and lasts several hours, but the depression may persist much longer. It is not used in veterinary medicine. Average dose, dog, 5 grains (0.3).

* **Bromural** (monobromiso-valeryianyl-urea) resembles veronal but is less active.

Urethane (æthylis carbamas U. S. P.) occurs as colorless, columnar crystals or scales, odorless and having a cooling saline taste. Soluble in water, alcohol, ether, chloroform and glycerin. It is a mild hypnotic and diuretic. Decomposes in the body to urea. Average dose for dog, 1 dram (4.0).

* **Hedonal** (methylpropylcarbinol-urethane) occurs as a white powder sparingly soluble in water but readily soluble in other organic solvents, and of faint aromatic odor and taste. This appears to have a greater hypnotic effect than urethane, but is also unreliable. Average dose for dogs, 15 grains (1 gm.). Federoff (1910) recommended it as an intravenous anesthetic. Page (1912) recommended a solution of 0.75 per cent. in normal saline given at the rate of 150 mils per minute, adult dose (in human), 500 mils; while Veale (1912) used it in quantities up to 1200 mils but found larger amounts dangerous, causing edema of skin and lungs, bronchitis and pneumonia.

CANNABIS

Synonym. Hemp. Indican Cannabis

Parts Used. The dried flowering tops of the pistulate plants of *Cannabis Sativa, Linne,* or of the *variety indica, Lamarck,*

* Unofficial.

gathered while the fruits are yet undeveloped and are carrying all their natural resin. Haschish, bhang, charas, ganga, etc., are different preparations of the drug used by the natives of the East as habit drugs. The United States Pharmacopœia requires a physiological assay of preparations of cannabis.

Constituents. Cannabis contains 29 per cent. of resin, a volatile oil, and very minute amounts of an alkaloid cannabinine and some other alkaloids. Its activity is due to the resin. Cannibinol is a mixture consisting chiefly of resin and oil. Cannabis is very variable in strength unless standardized, and furthermore, tends to deteriorate. It was formerly supposed that the Indian plant was a distinct species but it differs so little from other forms that botanists now agree that it is merely a different variety. It was also thought to contain no medical properties when grown in temperate climates and that only the Indian variety was of therapeutic value. Experiments, however, have shown that other varieties are valuable, especially Cannabis Africana and Cannabis Americana. The fluid-extract of either is now standardized by the best pharmaceutical houses so that the dose is the same as that of the Indian drug. Water precipitates the resin.

Preparations and Doses.

Extractum Cannabis. H. ʒss—ij; 2.—8. D. gr. ¼—ij; 0.015—0.12.

Fluidextractum Cannabis. H. ʒiv—viij; 16.—30. D. ♏ i—x; 0.06—0.6.

Tinctura Cannabis. H. Not used. D. ♏ xv—xxx; 1.—2.

External and Local Action. There is no action on the unbroken skin but it may be slightly sedative to mucous membranes.

Digestive Tract. Cannabis has no direct effect upon the digestive tract. Its use is not followed by constipation or other bad effects.

Nervous System. Cannabis is a distinct depressant to the brain and cord. In man this action may be preceded by a brief period of stimulation but this action is rarely seen in the horse. It is a distinct depressant and hypnotic and probably ranks ahead of opium for this purpose in equine practice. After full doses the animals feel drowsy, sleepy, have a disinclination to move and may finally pass into a stage of narcosis which may last from 12 to 24 hours, and then recover. There is some difference in the action of cannabis on different animals and occasionally there is an idiosyncrasy toward the drug. Some dogs show delirium and mania instead of depression.

Respiratory and Circulatory Systems. These are but little influenced although there may be some acceleration of the pulse

if the drug is smoked and inhaled in man, or if the dose is very large, in horses, although the usual effect from narcotic doses is to slow the heart. The respirations may be accelerated somewhat if the period of excitement is present but are slowed during the narcotic stage.

Cannabis is comparatively nontoxic to the domestic animals. Winslow says, "A horse receiving ½ ounce of the solid extract became drowsy. Sleep after a few hours passed into stupor, and stupor into coma. The respirations became slow, the pulse slightly accelerated, and the animal so anesthetic that amputation of the penis was done on the following day without producing the slightest pain or struggling. The animal had to be supported in slings and only recovered after three days."

Muir (1900) gave large doses intravenously to horses, as much as 15 mils to a 575 pound pony and 45 mils to a 1050 pound horse. Both animals were at first much excited and delirious, the first passing into sleep in a very few minutes, the second remaining excited for twelve to twenty-four hours. Muir concludes that 50 mils can be given with safety intravenously to a horse.

Hoare says, "In the dog 10 grains to 2 drams produce stupor and paralysis of the hind limbs; the narcotic condition may last for two days and the animal recover."

Therapeutics. *Cannabis is Indicated for the Relief of Pain, Spasm and Nervous Irritability.* It is superior to opium or morphine in equine practice and, although its action is not so rapid when given per os as morphine hypodermically, it is more reliable than either opium or morphine. It is especially superior to opium or morphine for the relief of pain and spasm of the intestinal tract because it does not tend to cause constipation. It is occasionally employed to control the spasms of chorea, epilepsy, tetanus and cough.

As a Narcotic for Operations Upon the Horse. Many veterinarians are employing cannabis intravenously to produce a state of narcosis sufficient for many operations upon the horse. The fluid-extract is given intravenously in from 5 to 10 mil doses, and narcosis takes place quite promptly.

Administration. Cannabis may be given per os in capsule, with a syringe or in a drench with water. Water precipitates the resin but does not appear to interfere with the action of the drug. It may be administered intravenously as the fluid-extract. Some clinicians filter it just before its intravenous administration, others do not. Although it is claimed by some that there is danger of embolism on account of a precipitation of the resin in the blood, there are no reported bad effects from its use in this manner.

It should not be used subcutaneously, since the resin is not absorbed rapidly from the subcutaneous tissues.

BROMIDES

The most common bromides used for narcotic effect are those of potassium, sodium and ammonium, and to a small extent those of lithium, strontium, calcium and zinc. Their characteristics are similar. All occur as colorless crystals, or white granular powders, of strong salty, bitter taste, are very soluble in water and moderately soluble in alcohol, with the exception of that of potassium. The dose is practically the same for each salt.

Horses and cattle, ℥j—ij; 30, 60.

Dogs, grs. v—lx; 0.3—4.

Diluted (10 per cent.) hydrobromic acid is sometimes used for the bromide action but has no advantage over the alkaline salts.

Doses. H. ʒ ij—vj; 8.—25. D. ♏ x—xxx; 0.6—2.

Physiological Action. The action of the bromides depends both upon the bromine present and the other element of the combination, since all are dissociable. Thus, each salt shows a certain amount of variation from the others. The action of the bromine, however, is distinctive, but the action of the other elements are also distinctive. Since Potassium Bromide is most frequently employed it will be discussed first and the difference between it and the others pointed out later.

External and Local Action. There is no effect upon the unbroken skin. Upon raw surfaces and mucous membranes it has a salt action and is irritant unless well diluted. If well diluted it is slightly sedative to mucous membranes, and lessens reflex excitability, especially of the pharynx. Before the days of cocaine, solutions of the bromides were painted in the throat as mild anesthetics to favor laryngeal examination.

Digestive System. Potassium bromide causes irritation and salivation due to its salty taste. Excessive doses may cause nausea and looseness of the bowels. It is freely and rapidly absorbed, traces being found in the urine within a few minutes after administration. The salt is quite evenly distributed in the body but the chief action is upon the nervous system.

Nervous System. There is a moderate but lasting depression on the whole nervous system that may be maintained for several days with little if any effect upon the medullary centers. Potassium bromide depresses the cerebrum diminishing the sense of pain and special senses. Large doses cause drowsiness and favor sleep in the human subject, but enormous doses will not force sleep in the day time or if the patient is up and about. The motor areas in the cortex are also depressed. Reflex activity is also lessened so that the drug acts opposite to strychnine. The depression of the reflexes gives a general depression of muscular tone throughout the body and

a loss or depression of the sexual reflex and usually that of the bladder.

Respiratory System. Full doses slow and depress the respirations, owing to a slight depression of the respiratory center. Therapeutic doses have no effect except to diminish the cough reflex and lessen the tone of the respiratory muscles.

Circulatory System. In ordinary doses there is no effect but in large amounts the circulation is depressed, the heart beat is slower, softer and weaker with a shortened systole and lengthened diastole. The blood vessels are dilated and blood pressure is lowered. The potassium ion is responsible for this action upon the heart as the other bromides do not have any such action.

Sexual Organs. Both sexual desire and power are diminished through depression of the cerebrum and cord.

Bladder. There is a marked diminution of the functional activity and muscular power of the bladder under long continued doses.

Absorption and Elimination. Potassium bromide is rapidly absorbed and begins to be quickly eliminated, chiefly by the kidneys (increasing the secretion of the urine). It is also eliminated by the skin, saliva, mammary glands and bronchial mucosa. Under prolonged dosage, it tends to accumulate in the body, being found in all parts, especially the blood.

Temperature. Large doses lower temperature by depressing the circulation.

BROMISM

Bromism or chronic bromine poisoning is shown by drowsiness, depression, some cutaneous anesthesia, muscular weakness, poor circulation, cold extremities, anemia, and cutaneous eruptions. The treatment consists in withdrawing the drug, and aiding its elimination by administering sodium chloride which hastens its excretion. Administer plenty of water. Diuretics and purgatives should also be given. Keep up the body activity and administer stimulants such as caffeine and strychnine as the physiological antidotes.

Comparison of the Bromides. With a few minor exceptions the bromides are identical in action. Potassium bromide contains 66 per cent. of bromine and is the most toxic to the heart and muscular system. Sodium bromide contains 78 per cent. of bromine but is less hypnotic than the preceding salt as sodium increases cerebral activity but, on the other hand, since the sodium ion does not affect the heart and muscles, it is less toxic.

Ammonium bromide produces some slight cardiac stimulation on account of the ammonium ion, but otherwise is identical in action with the potassium salt.

Lithium bromide is the most hypnotic of the group. It contains

92 per cent. of bromine and closely resembles the sodium salt in action.

Therapeutics of the Bromides. Since the bromides are especially serviceable in the treatment of functional nervous disorders they are not nearly so serviceable in veterinary as in human medicine. They are especially indicated to control the convulsions of epilepsy in both human and veterinary medicine. Their use in veterinary practice is largely limited to small animals, in which case they may be employed to control the spasms of epilepsy, epileptiform convulsions and eclampsia. However, they are of doubtful value in the convulsions of distemper, etc. Although they act opposite to strychnine, they are not reliable antidotes to poisoning by this drug.

For epilepsy or ether convulsive attacks they may be combined with chloral and administered per rectum.

Epilepsy or Convulsion in Dogs.

℞ Sodii Bromidi.
Potassii Bromidi āā..... grs. lxxxv
Ammonii Bromidi ..... grs. xxvij
Aquæ q. s. .....ad. ℥ iv
Misce et fiat Solutio.
Sig. Tablespoonful every four hours.

ANTISPASMODICS

The most important antispasmodics have been discussed in connection with other groups. Two which have not been discussed are:

Asafœtida and Valerian.

ASAFŒTIDA

This is a gum resin obtained from the roots of *Ferula fœtida,* a native of Persia and Afghanistan. It occurs in irregular crystalline masses or tears, is of a yellowish brown color, persistent garlicy odor and acrid taste.

Preparations and Doses.

Asafœtida. H. and C. ℥ss—j; 15.—30. D. gr. iij—xij; .18—.8.

Emulsum Asafœtidæ 4 per cent. in water. D. ℥ss—j; 15—30.

Tinctura Asafœtidæ. H. ℥ij—iv; 60.—120. D. ℥ss—j; 2.—4.

Pilulæ Asafœtidæ (3 grains each). D. 1—4 pills.

Action and Uses. Asafœtida is a feeble carminative, circulatory and nervous stimulant, and antispasmodic. It is used entirely as an antispasmodic and carminative. It is useful in colics and

convulsions of the young and may be of considerable service when administered in an enema.

It has been used externally to stop feather pulling of birds and to prevent bandage chewing with dogs.

VALERIANA — VALERIAN

Valerian is the rhizomes and roots of *Valeriana officialis,* a plant of Europe. It contains a volatile oil and valeric acid.

Preparations and Doses.

Valeriana. H. and C. ℥j—ij; 30—60. D. gr. x—℥j; 0.6—4.
Tinctura Valerianæ. D. ℥ss—j; 2.—4.
Tinctura Valerianæ Ammoniata. D. ℥ss—j; .2.—4.

Action and Uses. Valerian has the usual effect of a volatile oil and so is carminative. It slightly stimulates the heart, vasamotor and respiratory centers. It has been recommended as an antispasmodic and antihysteric in human medicine, but since it produces this action by stimulating the highest centers which exert psychic control, it must be of doubtful value in veterinary medicine.

The valerates (valerinates) of zinc, iron, quinine and ammonium do not have carminative action and exert but little of the action of the liquid preparations. *Average dose.* D. gr. ij—v; 0.13—0.3.

Valerian and the valerates have been especially recommended for the treatment of chorea in dogs but the results have not been satisfactory.

ANESTHETICS

Theories of Narcosis. Several theories have been advanced as to how the narcotics reach the cerebral cell contents and anesthesia is produced. The most generally accepted of these are:

1. **Meyer-Overton.** This was advanced by Meyer and Overton separately. They believe that these drugs exert their chief action upon the central nervous system, because they are taken up by the fats and lipoids, lecithin, cholesterin, cerebrin, etc., which are abundant there, and are held in contact with the cell structures. According to these men the anesthetic properties increase with the solubility in fats and lipoids and insolubility in water. This relationship of solubility of hypnotics and anesthetics is at least very striking and there seems to be considerable evidence to support this theory, which is the one generally accepted. It shows simply how the brain cell is reached, but does not explain the action upon it.

2. **Moore and Roaf.** This theory is based upon the assumption that anesthesia or narcosis is due to a change in the protoplasm of the cerebral cells by the formation of loose compounds of ether,

chloroform, etc., with the cell proteids, which results in the limitation of the activities of the cerebral protoplasm. Since the compounds are unstable, they remain formed only so long as the vapor-pressure of the anesthetic is maintained in the blood, so that narcosis ceases soon after the stopping of the administration. They do not doubt but that a certain amount of anesthetic will be taken up by a lipoid in a physical fashion, on account of the great solubility of the anesthetic in the lipoids. But they hold that the portion so taken up and held by the lipoid is passive and not active, and that it is the portion taken up by the proteid which is active in paralyzing the activity of the protoplasm and causing anesthesia. These men also strengthen their theory from the preceding by the fact that the greater amount of fatty tissue in the patient to be anesthetized, the greater is the amount of anesthetic required. They further contend that the portion of the anesthetic retained by lipoid is imprisoned and more anesthetic must be given to raise the "vapor-pressure" of the anesthetic sufficiently to cause a combination between cell protoplasm and anesthetic with anesthetization as the result.

The first of these theories assumes that the ether dissolved in the fats and lipoids is the anesthetic part; the other, that this ether is locked up and the anesthetic ether is that which enters into combination with the cell proteids.

3. **Verworn.** This theory accepts the Meyer-Overton theory in so far as it shows the necessary properties for an anesthetic to reach the field of action, but Verworn goes further and explains the depression of the activity of the brain cells. He shows that in narcosis there is interference with the oxidative processes of the cells or that "the factor which produces the symptom-complex of narcosis is under all circumstances the suppression of the power to carry on oxidation," the supposition being that narcotics render the oxidases (oxygen carriers) in living tissues incapable of carrying oxygen. He shows that this may take place in any cells of the body, but that the cells of the cerebrum are especially sensitive to a lack of oxygen and are depressed with very much less of the narcotic than is necessary to depress the nerves and muscles.

ANESTHESIA

When a general anesthetic is administered in sufficient quantity to put the animal in a state of coma, accompanied by relaxation of the muscles, and abolition of all the reflexes, the patient is in a state of complete general anesthesia. Anesthesia may be practically considered in the light of toxicology; and the production of it is really an acute poisoning of the various drugs, the patient being carried through the different degrees of poisoning into a state of narcosis which is just short of collapse.

Properties of General Anesthetics. In order to be of use as a general anesthetic, a drug must be very rapidly absorbable, produce anesthesia very quickly, and be rapidly eliminated. Furthermore, it should produce muscular relaxation as well as complete unconsciousness, i.e., abolish cerebral and spinal activity without dangerous depression of the vital centers in the medulla or permanent derangement of the central nervous system. Since these drugs are very volatile and their vapors are absorbed rapidly by the lungs, their administration by inhalation is preferred, as it is more easily controlled, but, on the other hand, a sufficient amount given per os, rectum or intravenously will produce the same action.

The principal members of the group of anesthetics are chloroform, ether, nitrous oxide, ethyl chloride and ethyl bromide.

Anesthesia. For the convenience of study the action of anesthetics is usually divided into three stages, but since these stages are only different degrees of the same action and there is no real line of demarcation between them, it is quite optional where the line of division is made. In human medicine four stages are usually described: stimulant, narcotic, anesthetic and paralytic. Since the first two cannot be easily differentiated in the domesticated animals, it seems well to discuss anesthesia in the three stages, stimulant, anesthetic and paralytic.

Stimulant. This is characterized by stimulation of the cerebrum and cerebellum and is manifested by great excitement and involuntary movements. The first few inhalations may produce a sensation of asphyxia, so that the respirations are often stopped voluntarily. The pulse and respirations are soon accelerated and the pupils dilated. During this period the horse often whinnies and the dog barks. All the above symptoms are due to excitement or stimulation. There is usually an increased secretion of saliva, mucous and tears, probably due to the irritant action of the drugs upon the parts involved.

Anesthetic. This is the condition it is desired to produce and maintain. It is characterized by complete paralysis of the brain, and motor reflexes in the spinal cord and depression of all the centers in the medulla. Consciousness, sensation and most of the reflexes are lost, the corneal reflex being one of the last to go. All voluntary muscle is relaxed but smooth muscle is not so apt to be affected, although there may be some relaxation of the sphincters. The pulse is slow, full and soft on account of lowered blood pressure. The respirations are regular but shallow. Temperature falls on account of lessened heat production and increased heat loss. Since the patient will not feel pain and the reflex activity is so lowered that the heart will not be reflexly inhibited by the shock of the operation, this is the period during which it is desired to operate safely.

Paralytic. This period is characterized by progressive paralysis of the centers in the medulla with total abolition of the reflexes, even the lowest ones being depressed. This period should be avoided unless it is desired to kill the animal. Feces and urine may be passed involuntarily, the respirations become shallow, labored and then cease, the pupils are widely dilated. The pulse is slow, weak and generally persists in normal animals after the respirations have stopped. It is generally concluded that death in anesthesia is due to paralysis of the respiratory center, although the heart stops so soon after the cessation of respiration that it is immaterial which is the cause of death. Both are much depressed and the weaker goes first.

General Uses for Anesthesia. To relieve pain, overcome spasm and relax the muscles. For these purposes they are used in surgical operations, in labor to check straining, to subdue the convulsions of tetanus, strychnine poisoning, etc.; to facilitate the reduction of fractures, luxations and hernia, and at the same time overcome the pain of the operation.

CHLOROFORMUM — CHLOROFORM

Chloroform is a heavy, volatile, noninflammable, colorless liquid of peculiar odor and burning sweetish taste, made by the action of chlorinated lime on alcohol, or by treating acetone with chlorinated lime in the same manner. The latter method is now preferred because the yield is better and the product much purer than that produced by the alcohol process. It is soluble in 200 times its volume of water, to 4 per cent. in blood serum, and in all proportions in alcohol and ether. It should contain from 99—99.4 per cent. by weight of absolute chloroform and from 0.6—1 per cent. of alcohol to meet the standard of the United States Pharmacopœia. On long standing or when exposed to sunlight or a flame, chloroform may decompose with the formation of free hydrochloric acid, or the poisonous carbonyl chloride, or free chlorine, which is very irritating. Alcohol acts as a preservative since chloroform does not undergo decomposition so long as there is any alcohol present to be oxidized. Hence the pharmacopœia specifies that the above amount of alcohol must be present.

Preparations and Doses. For internal administration.

Chloroform. H. 3j—ij; 4—8. D. ♏ ij—xv; 0.13—1.0.
Aqua Chloroformi (water) ½ per cent. As a vehicle only.
Spiritus Chloroformi (6 per cent.). H. ℥j—ij; 30.—60. D. 3ss—j; 2.—4.
Emulsum Chloroformi (4 per cent.). D. 3j—iv; 4.—16.
Linimentum Chloroformi, composed of chloroform 30 parts and soap liniment 70 parts.

External and Local Action. If allowed to evaporate upon the skin, chloroform produces cold with constriction of the blood vessels together with local anesthesia, but if the vapor is confined or the drug is rubbed into the skin it is an irritant, causing redness and vesiccation. Chloroform is also antiseptic; even in dilute solutions (the aqua) it will prevent or retard putrefaction and fermentation as in urine.

Digestive System. If administered per os in strong solution, chloroform is irritant to the mouth, throat, and stomach. Dilute solutions produce a sensation of warmth to the stomach, increase the saliva, gastic and intestinal secretions, stimulate peristalsis and aid in the expulsion of gas. In other words, it is a carminative. It may also be soothing to the stomach and antemetic in weak solution.

Circulatory System. Blood pressure is always lowered by anesthesia with chloroform. This may be somewhat accounted for by depression of the heart and to some extent by the dilatation of the blood vessels from depression of the vasomotor center. Occasionally death occurs early in chloroform anesthesia from reflex stimulation of the vagus and consequent stopping of the heart. A strong concentration of the vapor is more dangerous in this respect than a weak one.

Respiratory System. There is a decided depression of the respiratory center preceded by a very short period of stimulation. In some cases respiratory paralysis is the cause of death, and in experiments with much diluted vapor the respiration regularly ceases before the heart; but the heart is too weak to permit of resuscitation.

Absorption. Chloroform is rapidly absorbed from the gastro-intestinal tract and from the lungs when inhaled. The changes which it undergoes in the body are not well known. It is mostly excreted by the lungs, some by the kidneys and a small amount seems to be oxidized in the tissues.

Metabolism. The prolonged administration of chloroform increases the amount of urea, phosphates and sulphates in the urine and has a tendency to cause fatty degeneration in the internal organs, in the following order of extent and frequency: Liver, kidneys, spleen, heart, arteries, and cardiac ganglia and, perhaps, the lungs. The main effects upon metabolism are due to the marked destructive changes in the liver. There is a decrease in the storage of glycogen and, as a consequence, an increase of sugar in the blood. In the urine there is an increase in phosphates, chlorides, sulphates and total nitrogen, the ammonia nitrogen being increased while the urea is decreased. The urine sometimes contains sugar, acetone and allied bodies, and cystin, leucin or tyrosin. These effects are evidences of increased destructive metabolism with incomplete oxidation.

The Action on the Nervous System. The action of chloroform (and ether) upon the nervous system is pretty well described under anesthesia. The action in general is a progressive descending paralysis of the central nervous system. The higher cortical functions pass through a brief period of stimulation, followed by a complete, but temporary, loss of function. The suspension of function involves first the cerebral cortex and the great tracts of the sensory and associated centers, later the spinal reflexes and finally the great vital centers in the medulla. Death during chloroform anesthesia is due to paralysis of the respiratory center unless there is a sudden reflex vagus stimulation and consequent stoppage of the heart, in the early stages of anesthesia.

Causes of Death from Chloroform Anesthesia.

1. Reflex stimulation of the vagus and consequent stopping of the heart in the early stages of anesthesia. This is usually due to too concentrated vapor.

2. Paralysis of the medullary centers and paralysis of the heart. The respiratory center is usually affected earlier than the other centers or the heart. It should be kept in mind, however, that there is no specific action upon the respiratory center but that all the centers are depressed and that the respiratory is the first to become paralyzed. These vital centers are all depressed and the weakest is the first to go. If the heart is diseased it may cease before the respirations stop.

3. From a toxemia caused by degenerative changes in the internal organs, particularly the liver, in from twelve hours up to four or five days after anesthesia. Cats are very prone to this form of poisoning.

Therapeutics. 1. *Anesthetic.* Chloroform is the best agent for general anesthesia of the horse, but on account of its dangerous complications is not to be especially recommended for cattle, sheep, dogs and cats.

2. *Carminative.* In flatulence and intestinal colic and diarrhea. Generally employed here as the spirit or emulsion in dilute solution.

3. *Antemetic.* It may prove of considerable use in serious cases of vomiting in the dog and cat. For this purpose, one-half to one dram of the water may be given every hour.

4. *Specific for eclampsia* of suckling bitches.

5. *Vermicide.* Chloroform is a fairly reliable vermicide for round worms and is prescribed with castor oil for this purpose.

6. *Antidote to strychnine poisoning.* It is particularly serviceable in this case when the convulsions are very severe. It should be given by inhalation, by means of artificial respiration. It is better to change to ether when relaxation occurs, since ether is not so depressant to the respiratory center.

7. *For cough.* Combined with belladonna and opium and prescribed with glycerin, syrup or mucilage.

8. *Externally.* It is useful as a liniment for counter-irritation and for the relief of pain.

Administration. For anesthesia of the horse, chloroform may be given by the drop or choke method. In the former, the lower nostril is plugged with cotton, the upper one smeared with grease, to prevent irritation of the drug, and the drug dropped upon a few layers of gauze held over the free (upper) nostril. In the choke method, a few ounces of chloroform are poured upon cotton or other absorbable material, this is then placed in a tight nose bag and held to the nose. The choke method is much the more rapid, but by many operators is considered more dangerous.

Dogs may be anesthetized by the use of a hollow tin or leather cylinder covered with gauze over the outer opening, upon which the chloroform is dropped, or the vapor may be forced into a cone by forcing air over chloroform contained in a bottle.

Cats may be anesthetized the same way as dogs or placed in a tight box and the chloroform placed in it upon gauze, sponge, or cotton. The last mentioned method is not particularly good, as it is more liable to be followed by changes in the internal organs (delayed poisoning).

For internal use, chloroform should be made up in an emulsion, using three parts of glycerin, white of egg, and acacia, or the spirit may be diluted with water.

ÆTHER

Synonym. Sulphuric ether

Ether or ethyl oxide is obtained by distilling a mixture of sulphuric acid and alcohol. It occurs as a very volatile, light, colorless, limpid liquid, with burning unpleasant taste and a characteristic penetrating odor. It boils at about 35.5° C. (96° F.), is highly inflammable, and its vapor mixed with air is explosive. It mixes freely with alcohol, and chloroform, and is a solvent for resins, fats, oils, adhesive plaster and collodion. It is soluble in 10 parts of water.

Its principal impurities are acids, acetaldehyde and peroxides. Even in pure specimens, these impurities may develop in the presence of light and air. They are removed if the vapor is passed through water.

Preparations and Doses.

Ether. H. ʒj—ij; 30—60. D. ♏ x—lx; 0.6—4.

Spiritus Ætheris, Spirits of ether (32.5 per cent.). H. ʒiij vj; 90.—180. D. 3ss—iij; 2.—12.

**Compound spirit.* Hoffmann's Anodyne consists of ether 32.5 per cent., etherial oil 2.5 per cent., alcohol 65 per cent.

* Unofficial.

External and Local Action. Since ether evaporates very rapidly it produces extreme cold and anesthesia. The surface to which it is applied is white and bloodless from constriction of the bloodvessels and, if applied in the form of a spray, sufficient anesthesia will be produced for slight operations. If reasonable care is not taken in its application as a spray the skin may be frozen. If rubbed into the skin or if evaporation is prevented by a covering, ether is irritant.

Digestive Tract. In the mouth and stomach ether has an action similar to alcohol and chloroform. It causes a burning sensation in the mouth and salivation, increases the gastric secretion, movements and dilates the blood vessels. Consequently it is a carminative and may aid digestion. Soon after reaching the stomach it reflexly stimulates the heart, causing an increase in the rate and force of that organ and an increase in blood pressure, which persists for some little time. Ether is a good example of a diffusible or reflex stimulant.

Circulatory System. It is a reflex heart stimulant as discussed above. Under anesthesia, there may be a slight rise of blood pressure for a short time, but this soon reaches the normal condition or goes slightly below normal.

Respiratory System. Ether is a reflex stimulant of the respiratory system at first, increasing the rate and depth of the respirations. After absorption of ordinary amounts there is no appreciable effect, but large amounts, as in anesthesia, depress the respiratory center. The usual cause of death is asphyxia from respiratory paralysis.

Eye. The pupil is first dilated. In stupor it is contracted as in sleep; in anesthesia, mildly dilated; and in collapse, widely dilated.

Elimination. This is rapid. It is mostly eliminated by the lungs.

Kidneys. During anesthesia there is inhibition of the formation of urine, due to the contracted condition of the arterioles. After anesthesia, diuresis takes place. Albumen and acetone are frequently found in the urine for two or three days after anesthesia.

Nervous System.

Ether produces such similar results and the stages of anesthesia are so similar to those of chloroform that they need not be again discussed. The following differences should be made:

1. Chloroform is the more powerful anesthetic.
2. Chloroform paralyzes the heart much more frequently.
3. The above holds true for the vasomotor, and respiratory centers.
4. Ether is more irritating to the bronchial mucous membrane

and is therefore more liable to increase bronchitis in those already suffering with it.

5. Ether is more liable to irritate the kidneys and those suffering with the various forms of acute or chronic renal disease or even renal insufficiency should be subjected to ether anesthesia only when it is administered with great caution.

6. Ether never produces sudden reflex stimulation of the vagus and death in the early stages of anesthesia except in the cat.

7. In ether the period of excitation is much prolonged and consequently there is more struggling.

8. It must be given much more concentrated than chloroform.

9. Since it is inflammable it must not be used around an open flame.

10. Ether is the more generally used in the United States in human medicine and is to be preferred for small animals.

Therapeutics.

1. *Anesthesia.* For small animals.

2. *Circulatory and respiratory stimulant in collapse.* It may be given subcutaneously and is a good substitute for nitroglycerin.

3. *Carminative.* In flatulent colic, to relieve pain and expel flatus.

4. *Antispasmodic.* In spasmodic colic ether relieves the spasm, pain, and flatulence. It is also useful in other spasmodic conditions.

5. *Anthelmintic* for tapeworm.

For spasmodic colic, Horse.

℞ Ætheris ..... ℥ j
Chloroformi ..... ʒ ij
Tinct. Opii ..... ℥ ij
M. Ft. Haustus. Give at once in a pint of cold water or, better, in linseed oil.

A. C. E. MIXTURE

Many mixtures of chloroform, ether and alcohol have been advocated to combine somewhat the strong anesthetic action of chloroform with the less dangerous drug, ether. Of these mixtures probably the above holds first rank. It is composed of alcohol one part, chloroform two parts and ether three parts, by weight.

Hobday states that for young puppies and cats this is a better anesthetic than either chloroform or ether alone, and he prefers giving it to these animals by means of a special inhaler, in which the gas is forced out of a bottle holding the mixture. Various other proportions of these agents have been advocated by different authorities.

OTHER GENERAL ANESTHETICS

On account of the slow action of ether and the accidents which attend chloroform anesthesia, many substances have been advanced to replace them. Atropine and morphine, and morphine and hyoscine have been given considerable trial and may do well for operations upon the dog. *See morphine scopolamine,* p. 182. These preparations are not suitable for the other animals, because they do not produce the characteristic depressant action. Chloral, chloretone, etc., give nice results in laboratory animals, but since it is not easy to control the degree of anesthesia, they cannot take the place of chloroform and ether. Of all those advocated, Nitrous Oxide alone has been placed upon a firm base. It is exceedingly successful in short operations and may be administered with oxygen for longer ones. The others are Ethyl Chloride, Ethyl Bromide and Bromoform.

Nitrous Oxide. Laughing gas. This is a colorless gas with very slight odor and sweetish taste. It is not inflammable but supports combustion in lighted objects. This gas produces anesthesia in from ½ to three minutes, but has a very short period of action and its use was formerly limited to short operations, such as the extraction of teeth of human patients. More recently it has been found that if this gas is mixed with oxygen it may be administered over a long period of time and it is now used by many operators for most operations. Since nitrous oxide does not produce a complete relaxation of the muscles, ether is sometimes used along with the above mixture for this purpose. This anesthetic has not found much favor in veterinary practice because it is expensive, the apparatus is also expensive and cumbersome, and it is difficult to use because it is not easy to judge the condition of the blood (cyanosis) in veterinary patients.

ÆTHYLIS CHLORIDUM — ETHYL CHLORIDE

This preparation occurs as a highly volatile and inflammable gas, prepared by the action of hydrochloric acid on absolute alcohol. It condenses to a liquid at about 13° C. (55.4° F.) and is kept in sealed tubes under pressure. These tubes are made with a minute pin-hole nozzle covered with a cap or regulated with a valve, and on opening the valve or removing the cap, the liquid is discharged as a fine spray.

Local Action. On coming in contact with the skin, it evaporates very rapidly and freezes the tissues so that anesthesia of an instant's duration may be produced, which is sufficient for some slight operations.

Systemic Action. For general anesthesia, the drug is vapor-

ized into an inhaler. Anesthesia is produced very quickly (1—2 minutes) but without total muscular relaxation, and recovery is almost as rapid, on account of which it is difficult to maintain anesthesia for any length of time. Ethyl chloride is but little used in veterinary medicine and almost entirely as a local anesthetic.

Ethyl Bromide resembles the preceding drug, but is not so volatile. It has been practically abandoned.

Bromoform is not sufficiently volatile to be of use as a general anesthetic.

Untoward Sequelæ from Ether.

1. *Of respiratory organs.* Bronchitis, pneumonia or edema of the lungs may take place. Müller claims that there is greater danger of pneumonia if the anesthetic is repeated within a few days. The cause of these conditions is still in doubt, some authorities claiming that they are due to irritation and others that they are due to the patient catching cold. Stursburg, working upon dogs, found that if the ether were allowed to evaporate freely there was surface chilling with rise of blood pressure from reflex constriction of the internal arteries. This did not occur with chloroform. It was believed that the rapid evaporation of ether by the open method made the vapor very cold and this in itself might be enough to irritate the respiratory tract. On this account some anesthetists resort to warmed vapor. This point is not yet cleared up. Seelig found that the inhaled gas did not cool the trachea but that the rapid evaporation of the ether cooled the air about the patient.

2. *On kidneys.* Acute nephritis and acidosis sometimes follow ether anesthesia. This is frequently seen in cats, even following short periods of anesthesia. It does not appear until after several days (4—8). The symptoms are: rise of temperature to 103°—105° F., complete loss of appetite, dullness, stupor, and persistent emesis. The animals succumb in from 24—48 hours after the first symptoms appear. Autopsy shows acute parenchymatous degeneration of the liver and kidneys. The urine contains considerable acetone.

Measures to Prevent Complications from General Anesthesia.

1. Preliminary injection of sedatives. See Morphine scopolamine p. 182.

2. A hypodermic injection of a small dose of atropine might be given to stimulate the respiratory center, lessen the salivary secretion and prevent primary stimulation of the vagus.

3. Start anesthesia in dogs with chloroform to lessen the period of excitement. Then continue with ether as soon as the animal reaches the anesthetic stage.

4. To prevent acidosis, some recommend the administration of

sodium bicarbonate, per rectum, one-half hour before starting anesthesia, but the value of this procedure is in doubt.

Rectal or Colonic Anesthesia. Ether may be given per rectum after the bowel has been cleaned with a saline, sodium bicarbonate enema. Ether vapor is then passed in through a special apparatus, but this method was never very popular. Another way to produce rectal anesthesia is to inject ether and olive oil, 1 part of ether to 3 parts of olive oil, after emptying the bowel with an enema.

This method has not proved satisfactory because it was not easy to produce anesthesia in dogs, and cats suffered from secondary after effects as much as or more than when given ether by inhalation.

Intravenous General Anesthesia. In this method the anesthetic is injected intravenously. Chloroform and ether have been used. They are injected in dilute aqueous solution in saline or in blood serum. This method has not proved popular.

Intratracheal Insufflation. This method consists of passing the anesthetic through a catheter inserted down near the bifurcation of the trachea, and passing air and vapor down by means of pressure. This needs preliminary anesthesia to abolish the laryngeal reflex. To avoid rupturing the lungs by excessive pressure, this method requires a manometer, and has not been considered as feasible for veterinary use.

Treatment for Accidents During Anesthesia.

1. If the pulse becomes rapid and weak, withdraw the anesthetic and give salines.

2. For collapse:

A. If from ether, lower the head, raise the feet and give air. If from chloroform keep the body level, so as to avoid heart failure.

B. Keep up the body warmth.

C. Inject atropine, caffeine or camphor hypodermically. Camphor may be useful in chloroform collapse where the heart is at fault. Avoid alcoholic stimulants. Hobday recommends a full dose of hydrocyanic acid placed upon the tongue for chloroform poisoning in dogs.

D. If an ether case, give hot salines per rectum or infusion with adrenaline.

E. Start artificial respiration.

F. If the heart stops, massage the organ or inject a few minims of tincture of digitalis and adrenaline chloride into the ventricular cavity and massage.

Ether, whisky and strychnine hypodermically have repeatedly been shown to increase the collapse.

ALCOHOL — ETHYL ALCOHOL

Synonyms. Spiritus Rectificatus Br.; Spiritus G.; Spiritus Vini Rectificatissimus, Spirit of Wine, Fr.; Common or Grain Alcohol

There are two kinds of alcohol, ethyl and methyl, but the latter is not used internally in medicine because it is an active poison. It will be discussed later.

Ethyl or grain alcohol is a liquid containing 92.3 per cent. by weight or 94.9 per cent. by volume of alcohol and the rest of water. It is used in the following forms:

Alcohol as described above.

Alcoholum Dilutum. Diluted alcohol containing 41 per cent. by weight or 48 per cent. by volume of ethyl alcohol (equal volumes of distilled water and alcohol).

Alcohol Dehydratum. Dehydrated alcohol, absolute alcohol, contains not less than 1 per cent. by weight of water.

**Alcohol Deodoratum.* Deodorized alcohol contains 92.5 per cent. by weight of alcohol. The odor is removed by distilling over a 2 per cent. solution of sodium acetate.

**Spiritus Frumenti.* Whiskey, 44—50 per cent. of alcohol.

**Spiritus Vini Gallici.* Brandy, 39—47 per cent. of alcohol.

**Vinum Album.* White Wine, 10—14 per cent. of alcohol.

**Vinum Rubrum.* Red Wine, same strength as white wine.

Doses. Alcohol. H. ℥j—ij; 30.—60. D. ʒj—ij; 4.—8.

External and Local Action. Alcohol retards fermentation in yeast-formed liquors when it reaches about 10 per cent. of the liquid and checks it completely when about 15 per cent. A mixture of equal parts of red wine (12 per cent.) and water has killed typhoid bacilli in twelve hours, which makes it very evident that alcohol is antiseptic. Harrington and Walker have found solutions of about 70 per cent. strength to have greater antiseptic properties than stronger ones.

If applied to the skin and allowed to evaporate it is cooling, and tends to harden the skin, but if the evaporation is prevented it is an irritant, causing redness. It does not form vesicles. It is irritant to mucous membranes and raw surfaces because it abstracts water from them and coagulates the protoplasm, on account of which strong liquors should not be administered without dilution.

Digestive Tract. *Mouth.* In the mouth when concentrated there is a burning sensation. If retained for some time the albumen of the superficial tissues is coagulated and the mucous membrane becomes whitish. The coagulum is not permanent but is soon dissolved by the fluids of the tissues. Soon after the alcohol is placed

* Unofficial.

in the mouth there is an increased flow of saliva and the pulse is accelerated. The latter is purely reflex, as it occurs long before the alcohol can be absorbed.

Stomach. There is about the same sensation in this organ as in the mouth. If a small amount is given, the gastric vessels dilate, the mucosa becomes red and secretion increased. The result is that the appetite is sharpened. This may explain the custom of taking a "nip" before meals, and also explains how a little alcohol may aid digestion. The effect of large doses is quite different. The activity of the gastric juice is destroyed by precipitation of the pepsin. The walls of the stomach become inflamed, large quantities of mucus are poured out and if the overindulgence is continued, chronic gastritis results, the glands atrophy and we get the permanent dyspepsia of drunkards.

Intestines. If any reaches the intestines undiluted it would be irritant but the chances are largely against this. The pancreatic juice is increased.

Blood. Alcohol is very largely absorbed by the blood and lacteals. It increases, then decreases ameboid movements of the white cells. It hinders the oxyhemoglobin of the red cells from giving up the oxygen, hence diminishes the oxidation of the tissues. This factor, in habitual drinkers of large amounts, may lead to imperfect combustion of fat, which consequently accumulates in the tissues and results in obesity.

Absorption. This is rapid from the stomach and intestines. According to Von Noorden, 1.5 per cent. is excreted by the breath, ½ per cent. by the urine, and traces in the sweat.

Temperature. Alcohol is slightly antipyretic. This action is probably largely due to dilatation of the cutaneous vessels.

Summary of Action on the Circulation. The following effects are seen from moderate amounts:

1. The heart beats more rapidly and forcibly. Large amounts directly depress the heart muscle.
2. All vessels are dilated, especially those of the skin.
3. Blood pressure rises. These changes are but transitory because the stimulation is soon followed by depression and the heart beats more weakly and *is weaker* than before.

Circulatory System. Upon the administration of concentrated alcoholic solutions, there is an immediate rise in blood pressure, though the action of the heart remains about the same. Although this action lasts but a very few minutes, alcohol is very valuable in mild forms of collapse. This action is purely reflex as it occurs before absorption takes place.

Brooks, working upon unanesthetized dogs, found that while a striking reflex rise of blood pressure followed placing of alcohol in the mouth, which returned to normal in five to ten minutes, and was

then followed by a slow fall in pressure, that there was no rise in pressure when the alcohol was placed in the stomach through a gastric fistula, even in strengths up to 50 and 60 per cent. It is, therefore, probable that the reflex comes from the mouth.

Respiratory System. Alcohol stimulates the respirations in some animals. This is probably due to an indirect effect of alcohol through its action in the stomach and not to stimulation of the respiratory center. There is no stimulation in dogs and in other animals the stimulation is so slight and uncertain as to make alcohol of no therapeutic value in the treatment of respiratory diseases.

Skin. Slight diaphoretic.

Nervous System. The action of alcohol upon the nervous system is similar to that of ether, but it is modified by its lessened volatility and slower action. Alcohol depresses first the highest cerebral centers, the intellectual, then the lower, motor, etc., then the cerebellum, and the vital medullary centers. There may be a primary stimulation, but this is but momentary and alcohol cannot be considered as a cerebral stimulant. It is a true narcotic, standing in this series between the anesthetics and hypnotics.

Food and Endurance. Bastido summarizes the action as follows: "Alcohol cannot build up tissue, but can spare or replace the fats and carbohydrates for a time, and can prevent excessive protein destruction (tissue waste) for a time. It may, therefore, serve as a useful food in some conditions of great exhaustion or waste, where the tissues would otherwise be broken down to furnish the energy to maintain life. But in any case alcohol cannot be a profitable food for any length of time, because of its central nervous effects, and because it causes too marked wear and tear on the body structures. It is probable that in most conditions, sugar will be a better food."

Therapeutics. *Externally and locally* as an antiseptic for wounds or hands, as a refrigerant for bruises, swelling, etc. (spirits of camphor). To harden the skin and prevent bed sores in man. As a preventive of burns by phenol, it is the best remedy, as it prevents penetration of the phenol; but when phenol has been swallowed, alcohol may be given in the form of whiskey, but should be washed out because it only prevents the local action and at the same time increases absorption of it. As an antiseptic, see external and local action.

Internally:

1. Stimulant in collapse, either alone or combined with others.
2. In septicemia, snake bites, and pyemia, and infectious diseases.
3. Antipyretic. Increase dose given above and give every few hours. May be of service as food and narcotic but lowers resistance.

Horse Septicemia.

℞ Strychninæ Sulphatis .....gr. ss
Quininæ Sulphatis ..... ʒ j
Tinct. Ferri Chloridi ..... ʒ j
Alcoholis q. s. .....ad. ʒ jss
M. Ft. Solutio.
Sig. Give in six ounces of water, repeat every 3 hours,

4. To furnish food and stimulation in depressed conditions, and in convalescence.

5. Alcohol is almost universally used as a menstruum in the preparation of tinctures, fluid extracts, etc. It is often used as a liniment.

Denatured Alcohol is grain alcohol to which something is added so that it cannot be used internally.

METHYL ALCOHOL

Synonym. Wood alcohol.

Methyl alcohol is made by the destructive distillation of woods and is consequently known as "Wood Alcohol." It is also obtained as a by-product in the manufacture of sugar. It contains 84 per cent. of methylated spirit, some tarry constituents and fusel oils. It is duty free on account of its toxicity and is used principally in the arts and sciences.

Action. Methyl alcohol acts locally and centrally like Ethyl alcohol, but is somewhat slower in action and the depression is more persistent. Two great differences between methyl and ethyl alcohol are that methyl alcohol is not readily excreted or oxidized, its products formed in the body being formic acid and formaldehyde, and it is believed that these substances together perhaps with acetone are responsible for its toxic action.

The toxic effects are atrophy of the optic nerve with permanent blindness, and depression of cardiac and voluntary muscle resulting in death.

Many cases of death or blindness have occurred following its use. Although most of these results have followed debauches with adulterated spirits, many instances of blindness have come from hair tonics, bay rum, and other toilet preparations in which the cheaper liquid has been substituted. On account of this, the Health Department of New York City has an ordinance forbidding the use of methyl alcohol for any preparation for human use, either externally or internally.

DRUGS AFFECTING CHIEFLY THE PERIPHERAL NERVOUS SYSTEM

These may be divided into:

A. Those which depress the peripheral nerves, belladonna, cocaine,

B. Those which stimulate, pilocarpine, physostigmine and arecoline.

A. DRUGS DEPRESSING THE PERIPHERAL NERVES BELLADONNA OR ATROPINE GROUP

The belladonna or atropine group of drugs consists of a number of alkaloids of quite similar composition, which are found in a large number of plants belonging to the potato family or solanaceæ. Formerly each alkaloid received a specific name according to the plant from which it was obtained, but more recent investigation has shown that this group takes in several alkaloids and that each occurs in all the plants, but in variable proportion. The principle members of this group are:

Belladonna	Stramonium
Hyoscymus	Scapola

Similar alkaloids may also be obtained from the following plants: Duboisia myoporoides, and Mandrangana automnalis.

BELLADONNA

Synonym. Deadly nightshade

Parts Used. The leaves, folia, and roots, radix, of *Atropa belladonna* of central and southern Europe and western Asia and grown for the drug trade in England and Germany. Tradition has it that the drug was so named from the fact that it was used in early times by the ladies to produce lustre to the eyes. The term literally means "Beautiful Lady."

Active Principles. Belladonna contains two alkaloids, *Atropine* and *bellodonnine,* which is identical with hyoscyamine. In fact, recent investigations tend to show that atropine is an artificial alkaloid of hyoscyamine and that the latter is the true or natural alkaloid. Chemically atropine is a compound of the isomers, dextro and levo hyoscyamine, into which it separates when dissolved in water, while hyoscyamine is really levo hyoscyamine and is easily changed to dextro hyoscyamine.

Preparations and Doses.

Belladonna Folia. H. 3ij—viij; 8.—30. D. grs. ij—v; 0.13—0.3.

Tinctura Belladonnæ Foliorum. D. ♏ v—xxx; 0.3—1.3.

Fluidextractum Belladonnæ, Radicis. H. 3j—ij; 4—8. D. ♏j—iij; 0.65—0.2.

Extractum Belladonnæ Foliorum. H. gr. x—xx; 0.6—1.3. D. gr. ⅛—½; 0.008—0.03.

Linimentum Belladonnæ. 5 per cent. of camphor in fluid-extract of belladonna.

Unguentum Belladonnæ. 10 per cent. of pilular extract, 5 per cent. alcohol in hydrous wool fat 30 and benzoinated lard 35.

Atropine. H. gr. ¼—½; 0.016—0.03. D. gr. 1/100—1/20.

Action. The action of Belladonna depends upon that of its alkaloid atropine, so the two will be discussed together.

Summary of Action.

1. Stimulation of the nerve centers.
2. Depression of the nerve endings.

1. The nerve centers stimulated are the central and vital medullary and only in poisonous doses are these depressed.

2. The nerve endings depressed are:

a. Sensory nerve endings. There is a tendency to lessen sensation and pain, but not to produce anesthesia.

b. Motor nerve endings. In smooth muscles but not in striated or arterial muscle. There is a strong action in these muscles, tending to allay abnormal contraction of the muscles of the viscera, bronchi, stomach, intestines, bile ducts, etc.

c. Secretory nerve endings. There is a strong action on mucous, digestive and skin secretions.

4. Ends of oculo-motor nerves in the eye leading to a strong and lasting mydriasis.

5. Vagus nerve endings, so that the usual inhibitory control is lost.

Atropine is a selective acting drug because it depresses these nerves, whether applied locally or given internally, while there is no effect upon most protoplasm.

External and Local Action. If placed upon the unbroken skin, atropine has practically no effect, because it is not absorbed, but if it is mixed with some substance which is absorbed and rubbed into the skin or applied to raw surfaces it is an anodyne or analgesic, especially if pain is present, due to depression of the sensory nerves. It also depresses the terminations of the motor nerves of frogs, but this action has not been seen in mammals.

Digestive System. *Secretions.* The ingestion of therapeutic doses causes a decrease in the secretions of saliva and mucous by depressing the nerve endings in the glands and, consequently the mouth and throat become dry. The intestinal secretions tend to be diminished, although the action is somewhat different upon the different ones. The pancreatic secretion is dependent upon the presence in the blood of a chemic substance, *secretin,* rather than on nerve impulses, so atropine has little or no effect upon the amount

of its digestive elements, although it may diminish the watery elements by depressing the vagus endings.

The bile is but little influenced, but Bastedo says that atropine promotes the storing of glycogen in the liver by cutting off certain nerve impulses which induce the change of glycogen to sugar. It has on this account been recommended in diabetes and Forcheimer says, "in a large number of cases glycosuria, and with it acetone bodies have disappeared." On the other hand, Mosenthal, in careful studies of two diabetics, found no benefit or influence on the carbohydrate tolerance, although large doses were used.

Peristalsis. Atropine diminishes but does not entirely suspend the power of the vagus over the intestines, so that the cathartic drugs which act by stimulation of the vagus, arecoline, eserine, etc., may be checked, although atropine does not check peristalsis from cathartics which are direct irritants to the intestinal wall. On the other hand, atropine diminishes the so-called "tone waves" without checking peristalis, and tends to overcome spasmodic contraction with colicky pain caused by severe irritation or excessive vagus stimulation.

It is necessary to understand the difference between normal peristalsis and intestinal colic (which means any spasmodic painful contraction of the intestines, (*griping*) to understand just how the action of atropine upon the intestine is brought about.

In normal peristalis, a wave of contraction precedes the stimulating body for about one inch, while the bowel relaxes below the stimulating body for a considerable distance. In other words peristalsis is a coordinated purposeful action to propel the contents of the intestines and bring them in contact with the digestive juices. If, on the other hand, instead of this rythmic coordinated wave of contraction and expansion, we have a spasmodic contraction upon some offending body, which may even be gas or preceding a body which cannot be moved, we have intestinal colic or cramp (gripe). At the same time the contents are not expelled or propelled and constipation may result. In such cases atropine may restore normal peristalis by checking the spasm and, as a result, stop the cramp and constipation. It is on account of this action that atropine is added to irritant cathartics, because they sometimes produce this kind of colic. Large doses diminish or check peristalsis.

Circulatory System. Therapeutic or moderate doses of atropine accelerate the heart by depressing or paralyzing the terminations of the vagi in the heart. This action is so marked that a heart under the influence of atropine cannot be stopped even by strongly stimulating the vagus. Occasionally the heart is first slowed by stimulation of the vagus center before it is accelerated, but this is for but a short period and is unimportant. The force of the heart is also increased by direct action on heart muscle, so that there is

an increase of the output of the organ per unit of time. Blood pressure is raised by constriction of the splanchnic vessels, due to stimulation of the vasomotor center, together with acceleration of the heart. Simultaneously with the constriction of the vessels of the abdomen, those of the skin are dilated by excitation of the vasodilator center, so that the blood tends to flow from the deeper vessels to the more superficial parts. The dilatation of the cutaneous vessels, however, is insufficient to counteract the constriction of those of the abdomen, and blood pressure usually rises after therapeutic doses of the drug. Larger doses lower blood pressure immediately by action on the heart and even small doses do so sometimes. The dilatation of the skin vessels is more especially seen in those of the head and neck, and in man a flushed face or erythematous rash is characteristic of atropine poisoning. The heart action always persists after respirations cease, so that heart failure is not considered as the cause of death.

Respiratory System. Small and therapeutic doses stimulate the respiratory center and render the respirations quicker and deeper, thus increasing the amount of air inspired per minute. Following large doses, this quickening is frequently interrupted by convulsions, which may cause death. If respiration returns, it is slower and shallower during the stage of depression of the centers and respiratory failure is the cause of death in fatal poisoning. Animals are said to have recovered from six times the fatal dose if artificial respirations were used. In addition to the above action, atropine also paralyzes both the afferent and efferent vagal fibers in the muscular coat of the bronchi, so that this is relaxed and the secretions are not so irritating as before. The relaxation of the muscles of the bronchi causes these to dilate and it is probably due to this action that this group of drugs is so serviceable in treating heaves of horses. The secretions of the nose and throat are diminished. On account of the diminished sensation to the entire tract, together with the lessened secretions, cough is lessened.

Nervous System. Small or therapeutic doses have very little effect, but large ones stimulate the cerebrum and may produce nervousness, restlessness and delirium in man and occasionally in animals, followed by depression and drowsiness. It is not a narcotic in therapeutic doses. Convulsions usually occur finally from toxic doses, probably due to asphyxia brought on by cessation of the respirations.

Glands. All the secretions are diminished except the urine, milk and pancreatic juice. This action is due to paralysis or depression of the nerve endings in the secreting glands. The action on the mammary glands is explained by Bastedo, in the following manner: These glands have the power to secrete milk even after all their nervous connections have been divided. Therefore, atropine,

which simply cuts off the nerve influences, tends to reduce the milk, but cannot cause complete stoppage of it. The action is obtained both from external application and internal administration. The action upon the digestive glands and those of the respiratory system has been mentioned previously. The lack of influence upon the kidneys is due to the fact that the secretion of these glands is not so dependent upon nervous influences.

Eye. Atropine causes dilatation of the pupil, with loss of reaction to light, loss of power of accommodation and an increase in intra ocular pressure, and lessens pain. The dilatation of the pupil and loss of accommodation are due to paralysis of the endings of the oculo motor nerves, while the increase in pressure usually accompanies dilatation of the pupils, because this tends to shut off the escape of fluid through the spaces of Fontana at the margin of the pupil, into the canal of Schlemm. These effects are produced from both the local application and general application of the drug. Mydriasis will be produced in about one-half hour after local application of the drug, reach the maximum in ½—1 hour, and last for several days. Loss of power of accommodation is not produced so quickly and does not last so long.

Pain. Atropine gives moderate relief from the pain of iritis and other intraocular inflammations.

With Homotropine the effect is secured more promptly, but is not so persistent and consequently this drug is to be preferred for diagnostic purposes or for examination of the interior of the eye, while atropine is to be recommended when it is desired to keep the pupil dilated for a considerable period of time, as in iritis.

Temperature. Therapeutic doses have no effect upon the temperature, but large doses frequently raise temperature, probably on account of an increased circulation and oxygenation. Toxic doses lower the temperature.

Absorption and Elimination. Atropine is rapidly absorbed. It is quickly eliminated by the kidneys, although some is oxidized by the tissues. The greater part is eliminated by the kidneys unchanged.

Urinary Organs. The action upon the amount of urine is uncertain and unimportant: but in poisoning both suppression and retention have been reported. Since the drug is largely excreted unchanged, the urine is a dilute solution of it, and atropine will exert a remote local action in the urinary tract and lessen pain and spasm. In cases of poisoning, the urine concentrated by boiling and applied to the eye of an animal will dilate the pupil and hence may be employed as a test for poisoning.

Therapeutics.

1. *To relax spasm and over-contracted smooth muscle.* Belladonna is of but little service in general convulsion or those of spinal

or central origin, but is excellent in cases of local spasm of smooth muscle excited by peripheral irritation.

a. To relax spasm of the intestines. It is very useful in the various form of colic to overcome pain and allow the passage of the intestinal contents. It is frequently prescribed along with purgatives to lessen griping caused by them. It has been regarded as a good adjuvant to morphine in spasm of the intestinal muscles and was considered as a guard against the action of morphine. However, more recent investigation has shown that it should be used with caution in combination with morphine, since the combination checks the secretions, paralyzes the bowels and may bring on a fatal termination by stoppage of the bowels.

For action upon the bowel it is usually prescribed in one of the crude forms of the drug, the object being to produce a strong local action along the intestinal wall, with a slow absorption, since the alkaloids are absorbed too rapidly and may be absorbed from the stomach of some animals.

b. To relax spasm of involuntary muscles of other organs. It is often of service in spasmodic contraction of the ureters due to calculi, given either internally or hypodermically. In spasmodic attacks of asthma due to contraction of the bronchial muscles, it is the best agent at our command since it relieves the bronchial spasm by paralyzing the motor ends of the vagi, lessens secretions, lowers the sensitiveness of the mucous membranes to reflexes, and stimulates the respiratory center. It is also useful for spasmodic attacks of coughing for the same reason.

c. Heaves. Belladonna or one of the group will give temporary relief from the dyspnea of heaves and is frequently used by horse dealers for this purpose. Raitsits found that these plants do not merely reduce the number of respirations but also abolish the double period and the forced character of the respirations, so that they may appear normal, even in advanced cases. The effect is produced in 15 minutes and lasts about a day, but after the effect has worn off the dyspnea becomes more intense than previously. During the first hours after the administration the buccal mucosa is dry, the pupils dilate and do not respond to light, and the pulse is accelerated. Subcutaneous dose of atropine (0.03—0.05) produces the same effect but this comes on in a very few minutes, and only lasts from one to three hours.

2. *To check excessive secretions,* especially of saliva in mercurialism or other cases of salivation where it is used internally; in cases of excessive sweating; of bronchial and nasal mucous in bronchitis or coryza, especially in the free running stage. Results promptly follow its use in these conditions but since these are merely symptoms, the source or cause should be found and treated if possible. It is one of the best agents we have for checking the secretion of milk from an

inflamed udder. Although the action upon the secretion of milk is not always marked its application to the gland as an ointment or liniment and its internal administration may often give surprisingly good results. It is of no service to veterinary medicine as an antihydrotic but is very useful in human medicine to check the night sweats of tuberculosis.

3. *Stimulate the vasomotor center.* It is useful in shock and collapse, although less so than adrenaline, but it is particularly good in shock due from injury or the course of severe disease.

4. *Action upon the eye.*

1. As a mydriatic and analgesic for the following purposes:

a. Mydriatic to facilitate the examination of the interior of the eye, but is inferior to euphthalmin, cocaine, or homatropine as the action of these drugs is less persistent.

b. In iritis to keep the pupil dilated or to prevent or break up adhesions between the capsule and the lens it is superior to the above mentioned drugs.

c. Analgesic. An inflammatory condition of the external or internal parts of the eye, to give rest to the ciliary muscle, and to lessen pain. It is used in from ½ to 1 per cent. solution, but takes a long time for maximum dilatation but as the dilatation and paralysis of accommodation lasts for several days it is especially valuable for inflammatory conditions.

d. In acute keratitis to allay ciliary irritation.

5. *To allay peripheral irritation.* Ointments or plasters are useful in muscular rheumatism, lumbago, inflammations of the glands and joints. For this purpose belladonna is applied locally as the liniment, ointment or plaster or given per os for irritable bladder or urethra as in cystitis and urethritis.

6. *Stimulant to intestinal peristalsis.* Useful for this purpose in combination with other drugs (purgatives) in chronic constipation. By allaying spasm of the muscles of the intestines it prevents griping from purgatives and other causes. Small doses may even prove laxative.

7. *To impress the nervous mechanism of the heart* in tachycardia and nervous palpitation.

8. *To antagonize certain poisons* which are heart depressants, causing low arterial pressure: aconite, arecoline, etc.

9. *In the secondary stages of acute febrile diseases* such as bronchitis and pneumonia, belladonna or atropine in combination with strychnine is indicated to prevent effusion, and vasomotor depression, and to stimulate the respirations. The drug is particularly useful in pneumonia in case of collapse due to dilatation of the splanchnic vessels. The vascular system during the crisis of this disease is often found to be relaxed and cardiac stimulants do not seem to do much good. In this condition belladonna will increase the tone of

the arterial walls and produce great improvement. A large dose of atropine hypodermically is the best remedy for edema of the lungs or threatened edema.

10. *As a preliminary to general anesthesia.* In this case it is of service to check excessive secretions in the mouth and respiratory passages, to stimulate the respiratory center, and in chloroform anesthesia, to prevent the excessive reflex vagus stimulation at the onset of anesthesia.

11. *To stimulate the respiration* in general anesthesia, in pneumonia and collapse from narcotic drugs and to prevent respiratory depression, as when given with morphine. It is one of the best, if not the best respiratory stimulant we have.

12. *To check excessive vagus action,* as in the excessive inhibition stage of chloroform anesthesia and in vagus brachycardia or irregularity of the heart from disease or from a drug which strongly stimulates the vagus, as digitalis, arecoline, eserine, etc.

13. *In anaphylaxis.* Auer (1910) in experiments upon guinea pigs sensitized with horse serum, reported that without atropine 75 per cent. died, and with atropine only 28 per cent. died. Hare says that a hypodermic dose of atropine is the best agent we have to relieve the symptoms of anaphylaxis after the use of antitoxin.

HYOSCYAMUS

Synonym. Henbane

Parts Used. The dried leaves and flowering tops of *Hyoscyamus niger,* a plant growing in Europe, Asia and North America. These parts are collected from the plants of the second year's growth and should yield when assayed not less than 0.08 per cent. of mydriatic alkaloids.

Constituents. The active principles of hyoscyamus are two alkaloids, hyoscyamine, almost identical with atropine, and hyoscine, a distinct hypnotic.

Official Preparations and Doses.

Tinctura Hyoscyami. H. ʒj—iij; 30—90. D. ʒss—iij; 2.—12.

Fluidextractum Hyoscyami or Hyoscyamus. H. ʒij—viij; 8.—32. D. ♏ v—xx; 0.3—1.3.

Hyoscyamine or its salts. H. gr. ⅛—¼. D. gr. ¼₀—½₀.

Hyoscine or its salts. H. gr. ⅙—¼; 0.001—0.015. D. gr. ¼₅₀—½₀; 0.0004—0.0012.

Action. The actions in general are the same as those of belladonna, but hyoscyamus is a more powerful depressant. Hyoscyamine resembles atropine in its action, and paralyzes the identical structures paralyzed by it, but, according to Cushny, the action is about

twice as strong as by atropine. The action of hyoscine or scopolamine is quite different from hyoscyamine. Hyoscine depresses the endings of the same nerves as atropine but with a more powerful, prompt and less persistent action, depresses the cerebrum and produces sleep in man without a previous period of excitement. It also differs from atropine and hyoscyamine in being a distinct depressant to the vasomotor and respiratory centers instead of stimulating them, and in several instances collapse has followed small doses. It is considered as a distinct hypnotic in man.

Therapeutics. Hyoscyamus can be used in the same class of cases as belladonna or atropine but is often considered superior as a urinary sedative in the treatment of cystitis. It may prove more efficient to relieve pain in colic or intestinal irritations and the griping of purgatives.

Hyoscyamine. The uses of this agent are the same as those of atropine and belladonna but it cannot often be procured in a pure form and is not in any way superior to atropine.

Hyoscine. 1. Hypnotic. Good results are procured in man in maniacal excitement and delirium tremens. In veterinary practice it is used almost entirely as a hypnotic for canine patients in combination with morphine for the relief of pain, as a preliminary to general anesthesia or as a general anesthetic.

2. *As a mydriatic in 1 per cent. solution.*

Scopolamine-morphine anesthesia.

Hyoscine has been used very extensively under the name scopolamine, in combination with morphine, and it seems well to discuss it here. The uses of the combination are: 1, As an anesthetic, and 2, as a preliminary to general anesthesia.

1. *As an anesthetic.* In human practice about $\frac{1}{200}$ grain (0.0003 gm.) of scopolamine hydrobromide and $\frac{1}{8}$ gr. (0.008 gm.) of morphine hydrobromide or sulphate, are injected hypodermically two and a half hours and one and one-half hours before operating, and will in many cases often result in the abolition of pain. This has been recommended by different authors in surgery and obstetrics, yet in a large per cent. of cases, the anesthesia has not been sufficient and has had to be completed with ether. This is the combination which has won much notoriety through the magazines as the "twilight sleep" in human obstetrics. By some it is considered as entirely safe, by others, as undesirable on account of its liability to accident, necessity of close attention, on account of nausea, vomiting, excitement, delirium and collapse. The dose is not given sufficiently large to produce sleep but to dull the memory, so that everything which occurs during that period is forgotten. One company adds cactin, a glucoside of Cactus grandiflora, to the usual mixture aiming to counteract the action of morphine upon the heart, but Hatcher and others

have shown that cactin is not a cardiac stimulant and is consequently superfluous.

In veterinary medicine the use of the above treatment is confined to the surgery upon the dog and it has been found that it is not necessary to give several small repeated doses, but that one full dose may be given at one time, thirty to forty minutes before operating, in which case it will frequently produce sufficient anesthesia for ordinary operations or may be supplemented with a small amount of ether. Some writers believe that the combination is superior to morphine alone and some think that morphine is just as good. At any rate there is not the decided hypnotic action seen in the domestic animals as in man.

STRAMONIUM

Synonyms. Thornapple, Jamestown or Jimson Weed

Parts Used. The leaves and seeds of *Datura Stramonium* or *Datura tatula.*

Active Constituents. Stramonium contains an alkaloid, daturine, which exists as a combination of atropine and hyoscyamine.

Preparations and Doses.

Fluidextractum Stramonii (seeds). H. ♏ xv—3jss; 1—6. D. ♏ ss—iij; 0.03—0.2.

Tinctura Stramonii (seeds). D. ♏ ij—xx; 0.13—1.3.

Extractum Stramonii (seeds). H. grs. v—x; 0.3—0.6. D. grs. ⅛—¼; 0.008—0.016.

Stramonii folia. H. 3ss—ij; 2.—8. D. grs. j—iv; 0.065—0.3.

The action and uses of stramonium are practically identical with those of belladonna. It is especially valuable in asthma of dogs and heaves of horses. In the former case, the leaves may be burned in the room, and will often prove of much benefit. It is often preferred by horse dealers to belladonna for heaves in horses. For this purpose it may be combined with lobelia and followed by Fowler's Solution of arsenic. Animals are occasionally poisoned by eating thornapple. In this case the treatment is the same as in belladonna poisoning.

Scapola Atropoides. This drug contains hyoscyamine and scapolamine, which is identical with hyoscine. The action and uses are similar to those of hyoscyamus, over which it has no advantages. The other members of the group are of no importance.

℞ Aloes ..... ʒ v–viij
Hydrargyri Chl. Mitis..... ʒ ss
Ext. Belladonnæ ..... grs. xx
Pulv. Zingiberis ..... ʒ j
Excipient q. s.
M. Ft. Bolus. Purgative for horse.

Purgative for Dog.

℞ Aloini ..... gr. 1/8–1/4
Cascarini ..... gr. 1/8–1/4
Podophyllini ..... gr. 1/12–1/6
Ext. Belladonnæ ..... gr. 1/8
or Atropinæ Sulph..... gr. 1/500
Excipient q. s.
M. Ft. Pilula.

Cough. Horse.

℞ Pulv. Belladonnæ Foliorum.
Ammonii Chloridi .....āā ʒ j
Camphoræ ..... ʒ ss
M. Ft. Pulveris.
Sig. One powder two or three times daily.

For Mastitis

℞ Extracti Belladonnæ Foliorum..... ʒ ss
Glycerini ..... ʒ iv
Linimenti Saponis ..... ʒ vj
M. Ft. Linimentum.
Sig. Apply as directed.

Heaves.

℞ Liquor Potassii Arsenitis ..... ʒ xij
Fluidextracti Lobeliæ ..... ʒ ij
Fluidextracti Stramonii ..... ʒ ij
M. Ft. Solutio.
Sig. One-half ounce three times daily.

Edema of Lungs. Horse.

℞ Strychninæ Sulphatis.
Atropinæ Sulphatis .....āā gr. ss
Aquæ Destillatæ q. s. .....ad. ʒ ijss
M. Ft. Solutio.
Sig. For hypodermic injection.

Homatropine Bromide, U. S. P., is the bromide of an artificial alkaloid closely allied to atropine (tropine). It is soluble in 5.7 parts of water and is used entirely for its action upon the eye. Its chief advantage over atropine is that it is more rapid but less persistent in action and is therefore to be preferred for examination of the eye, but not where continuous action is desired, as in inflammatory conditions of the eye.

Euphthalmine is an artificial alkaloid of eucaine; it is used entirely as a mydriatic.

LOCAL ANESTHETICS

Drugs applied locally may lessen or destroy sensibility by a specific action on the sensory nerves, or by intense cold produced by their evaporation, as in case of ether or ethyl chloride. Some drugs

are also capable of producing numbness or anesthesia of the skin or mucous membranes when taken internally in sufficiently large doses (aconite). Local anesthetics are applied locally to relieve pain and allay itching. The following are most important:

Cocaine	Tropococaine	Eucaine	Orthoform
Anesthesin	Stovain	Novocaine	Holocaine
Alypine	Chloretone	Urea and quinine hydrochloride	

and less important:

Menthol	Ether	Ethyl chloride
Phenol	Aconite	Veratrin
Atropine		

Besides these many of the aromatic oils, like cloves and peppermint, also possess anodyne properties.

* COCA

Synonym. Cuca.

Parts Used. The leaves of *Coca erythroxylon or Erythroxylon truxillense* yielding when assayed not less than 0.5 per cent. of its ether soluble alkaloids, cultivated extensively in the high altitudes of Peru, Bolivia, and Ecuador and to some extent in Mexico and East and West Indies. The leaves also contain ergonine, and arygarine, but cocaine is the only important constituent.

Preparations and Doses.

**Coca or Fluidextractum coca.* H. ʒij—iv; 8.—15. D. grs. or ♏ xx—lx; 1.3—3.

Cocainæ hydrochloridum (Hydrochloride of cocaine) is soluble in 0.4 parts of water and 2.6 of alcohol. It is insoluble in oils, therefore for oily solutions the pure alkaloid should be used. Cocaine and its salts decompose at a temperature of about 98 C., so its aqueous solutions cannot be sterilized by boiling. Furthermore the solutions are not antiseptic and frequently show a growth of mold, but this may be prevented by the addition of boric acid.

Doses.

Cocainæ hydrochloridum. H. grs. v—x.
**Oleatum Cocainæ,* used externally only. D. grs. ⅛—¾.

According to Wooldridge the maximum dose for the horse is 10 grains. For dogs, ⅒ grain for each pound but not to exceed 2 grains, for the cat the same ratio per pound but not to exceed ¼ grain.

Coca leaves and their preparations are employed only to a very

* Unofficial.

limited extent, but the alkaloid cocaine is very extensively used as a local anesthetic.

External Action. Cocaine produces no action upon the unbroken skin because the drug is not absorbed, but if it is mixed with some substance which is absorbed, or is injected hypodermically or is in any way brought into contact with a nerve, it produces local anesthesia by paralyzing the sensory nerves. The part soon becomes pale on account of constriction of the bloodvessels. Very large doses may also paralyze the motor nerves. Anesthesia takes place in from five to ten minutes after its application and lasts for fifteen to thirty minutes, but may be prolonged and intensified by the addition of a small amount of adrenaline chloride solution, which constricts the bloodvessels and delays the absorption of the cocaine.

Anesthesia may be produced if the drug is applied to any part of the nerve, from its ending to its posterior root: so anesthesia may be obtained by:

1. Application to mucous membranes.
2. Injection beneath mucous membranes or skin.
3. Injection into a nerve.
4. Injection into the spinal canal which is known as spinal analgesia, or anesthesia. The motor nerves are not so readily affected.

Spinal Analgesia. To obtain spinal analgesia in man ¼—½ grain of cocaine hydrochloride in aqueous solution is injected into the spinal canal, the needle being inserted between the third and fourth lumbar vertebræ. The toes and perineum become anesthetic in about three to four minutes, and anesthesia rapidly ascends until it reaches the umbilicus, the entire body below the injection being anesthetized. Jonnesco has made the injections higher up in the cord, using a mixture of stovaine and strychnine. Although his reports are excellent the method has been abandoned in this country as unsafe. This method of producing analgesia in veterinary medicine has been confined to work upon the dog, but it has not gained much prominence.

Digestive System. Taken per os, the gastric mucosa is numbed and the sense of hunger lessened. Small doses are said to increase and large doses decrease peristalsis. Those taking cocaine or coca can go long periods and work for several days without food and apparently seem to have no sensation of hunger. The drug is not a food, however, as the body rapidly wastes. On account of its local anesthetic action cocaine is frequently used to control or check nausea and vomiting. Very large doses tend to paralyze the bowels and cause constipation.

Circulation. Probably cocaine has little direct effect upon the circulatory system, but the vagus is somewhat depressed and the pulse therefore quickened and more forceful. Large doses slow the heart. The effects of the drug upon this system vary greatly with

the dose employed. Small doses lessen the pulse rate, through stimulation of the vagus. Blood pressure is rapidly raised by stimulation of the vasomotor center, but this increased pressure is followed by a temporary fall. Moderate doses accelerate the heart, largely by depression of the vagus, both centrally and peripherally, together with some stimulation of the accelerator mechanism. Blood pressure is quickly raised on account of the action upon the heart and also on account of stimulation of the vasomotor center. The increased pressure may be so great in some cases as to demand treatment. Large doses give a very low blood pressure with a slow weak pulse, due to depression of the medullary centers. Occasionally an unexplained, almost instant collapse results in human patients after absorption, no matter how given.

Its local application constricts the bloodvessels.

Respiratory System. The respiratory center in the medulla is stimulated, causing an increased rate, with little or no change in the depth at first. Later the stimulation gives way to depression, and with large doses the respirations become shallow, while the rate may be increased still further. If convulsions result, the respiration is arrested, and, as after strychnine convulsions, may fail to be reinstated, or there may be a gradual respiratory failure.

Nervous System. Moderate doses strongly stimulate the higher parts of the brain and in the human family cause a sense of calm and happiness. The centers are stimulated in the same general order in which they are depressed by morphine, but the motor areas which are not depressed by morphine are actively stimulated by cocaine; this results in circus movements in some animals. The stimulation is followed by depression of the same areas, but the stimulation and depression are not at all uniform, so that one usually sees evidence of mixed stimulation and depression of the various centers during cocaine poisoning. Animals have greater endurance and the increased physical energy renders possible the performance of long exhausting muscular feats. This is probably the reason that cocaine is used as a stimulant (hop) in race horses. For the stimulant and exhilarating effects, coca leaves are often mixed with clay or ashes and chewed by the natives of Peru and the surrounding countries, but an overindulgence leads to indigestion and extreme emaciation. Large or toxic doses lead to depression, loss of coordination, narcosis and cerebral convulsions. The sensory nerves are paralyzed and the motor nerves depressed by toxic amounts.

Eye. A two to four per cent. solution causes marked irritation of the parts, together with a transitory contraction of the pupil, but this is soon followed by anesthesia of the cornea and conjunctiva and blanching of the mucous membrane. A few minutes later the pupil dilates and remains so for one or two hours, but there is not a maxi-

mum dilatation. The pupil still responds to light, and there is neither paralysis of accommodation nor increase in intraocular tension, so the effects differ from those following atropine.

Temperature. There is no effect upon the temperature from medicinal doses, but large or toxic doses cause an elevation of temperature.

Kidneys. There is an increased amount of urine voided but a decrease in the per cent. of urea.

Absorption and Excretion. Cocaine is rapidly absorbed from the gastrointestinal tract and from the subcutaneous or submucous tissues when the local vasoconstriction has passed away or if the solution is too dilute to cause constriction of the vessels. It is practically all destroyed in the body, so that there is no remote effect on the urinary system.

Toxicology. The symptoms of poisoning by cocaine are quite variable but usually consist of excitement followed by delirium and finally depression, stupor, rapid pulse, hurried respirations, dilatation of the pupils, increase of body temperature and convulsions.

According to Cushny, in the dog and cat the symptoms are invariably those of stimulation of the central nervous system. The animals show symptoms of great restlessness and excitement soon after the injection; they seem unable to keep still, the dogs at first showing all the signs of affection and excitement which they ordinarily display on being unchained or taken for a walk, but afterward running continually in a circle and paying but little attention to anything around them. Still later regular convulsions occur, first clonic, but may become tonic, and then resemble those seen in strychnine poisoning. Even before the convulsions occur the animals seem partially unconscious and in the intervals between the convulsions lie in an apathetic state, which soon dèepens to coma and death from asphyxia.

In the horse a toxic dose of cocaine (3j) causes restlessness and excitement, muscular twitching and trembling, rythmical movements of the head, dilated pupils and salivation followed within an hour by a stage of acute mania and great excitement.

Smaller doses (ordinary therapeutic ones) in certain individuals cause exhilaration, nervousness, excitement, dilatation of the pupils, twitching of the ears, and increased respirations. Race horses which have been stimulated with cocaine show these symptoms well and in addition do not cool out well.

Treatment. This is mainly symptomatic. For circulatory and respiratory failure, ammonia, strychnine and atropine. In convulsions chloroform or ether by inhalation, performing artificial respiration if necessary. For excitement use chloral or bromides or other sedative.

Untoward Effects. These are:

1. From protoplasmic irritation. Cloudiness and ulceration of

the cornea; necrotic area or sterile abscess at the point of injection.

2. After absorption, excitement and delirium.

3. Sudden collapse after usual doses in susceptible cases, but not often in animals.

Therapeutics.

1. *Externally.* Cocaine or its synthetic chemical substances or substitutes are the agents most generally employed for local anesthesia. The operations most suitable for local anesthesia are:

Removal of tumors	Operations on eye and throat
Tenotomies	Operations on the feet
Firing	Operations on mucous membranes, etc.
Neurectomies	

2. *To dilate the pupil* and is superior to atropine in many cases.

3. *To detect obscure lameness* by injecting a solution over the nerves supplying the part and thus removing all sensation beyond the point of injection.

4. *Internally.* It has been used as a central nervous stimulant in shock and collapse as in chloroform poisoning or narcotic drugs.

5. *To check nausea.* Cocaine and other members of the group may be useful to check nausea and vomiting of cats and dogs.

6. *General anesthetic.* Ritter, in 1909, obtained in dogs by injecting 10 mils of a 1—3 per cent. solution intravenously, general anesthesia lasting for 15 to 30 minutes. The animals remained awake, but quiet and indifferent and insensitive to pain.

7. *Intravenous local anesthetic.* Bier produced anesthesia in the limbs by placing a tourniquet above and below the point to be anesthetized and injecting the cocaine solution directly into the vein. This method is used considerably by some surgeons but has not been taken up by veterinarians to any extent. There is said to be some danger of clotting of the blood.

8. *Spinal analgesia.* See p. 186.

Strengths of Solution. A solution of from 1—2 per cent. is used for the relief of pain, but a stronger solution (4 per cent.) is required to produce complete anesthesia as in cutting operations. Four per cent. solutions may be too strong for application to the eye except for very brief periods.

Schleich suggested the use of solutions of different strengths (and with morphine without reason) for the infiltration method. This consists in injecting a relatively large amount — up to 200 mils (6 fluidounces) — of a solution of 1:10,000 in physiological saline through a fine needle and permitting it to permeate the tissues about the region to be operated upon. Relatively smaller amounts of solutions of 1:1,000 may be used in the same way. The solution, in human work, is injected into — not beneath — the skin at first, and then into the underlying tissues successively. This method

is painful when inflammation exists, and in such cases it is preferable to block the nerves supplying the parts. Schleich also believes that the local anemia due to pressure of the large amounts of solution aids in decreasing sensation. He also asserts that similar injections beneath the periosteum permit of operations on the bones. The anesthetic lasts about twenty-five minutes. He recommends three solutions of different strengths, as follows:

Solution	1	2	3
Cocaine hydrochloride	gr. iv (0.25)	gr. ij (0.12)	gr. 1/5 (0.012)
Morphine hydrochloride....	gr. 1/2 (0.03)	gr. 1/2 (0.03)	gr. 1/10 (0.006)
Sodium chloride	gr. iv (0.25)	gr. iv (0.25)	gr. iv (0.25)
Sterilized distilled water...	f℥ iv (120)	f℥ iv (120)	f℥ iv (120)

To each of these solutions 3 minims of a 5 per cent. solution of phenol are added. The second solution is the one most used, the first where acute inflammation is present and the third where it is necessary to use repeated injections. The effect of these injections may be considerably increased if adrenaline chloride in the proportion of 1—20,000 is added to the mixtures. This method of anesthesia has been given considerable trial and may be satisfactory for minor operations, but is not satisfactory for deep cutting operations or for operations upon the nerves.

COCAINE SUBSTITUTES

On account of certain drawbacks to cocaine, especially its poisonous nature, decomposition on sterilizing, poor keeping qualities in solution and occasional idiosyncrasy to the drug, several products have been advanced as substitutes for it. The following are the most important:

Novocaine (para-aminobenzoyldiethylaminoethanol hydrochloride) occurs as fine colorless needles that melt at 156° C., and are soluble in 1 part of water and about 30 parts of alcohol. Its solutions are neutral. Its aqueous solutions may be boiled without undergoing change. Toward alkalies and alkaloidal reagents it behaves like alkaloidal salts. Injected subcutaneously it manifests a strong but transient anesthetic action but is said to be absolutely unirritating. Braun combines the active principle of the suprarenal capsules with it to increase its action and says that so combined, it is as powerful as cocaine. It produces no effect upon the arterioles, and is not absorbed from intact mucous membranes, so is not suitable for operations upon the eye and throat, where dependence is placed upon the simple application of the drug. According to Schley, it is only about 1/6 as toxic as cocaine.

It is used in solutions of from 0.5 to 2 per cent. Crile recommends a solution of 1—400 to anesthetize the field of operation before cutting and thus prevent surgical shock to the tissues. This is, of course, supplementary to general anesthesia.

Novocaine Nitrate (para-aminobenzoyldiethylaminœthanol nitrate) occurs as small colorless, odorless crystals, soluble in water and alcohol. It is a local anesthetic that can be used with silver nitrate and other silver salts without fear of precipitation.

Eucaine (beta-eucaine or eucaine hydrochloride). This is the hydrochloride of trimethylbenzooxypiperidin, a synthetic product similar to cocaine. Formerly eucaine was also supplied as alpha-eucaine, but on account of its irritant properties, it was never widely used, and at the present time has been withdrawn from the market. *Beta-eucaine* occurs as a white powder, soluble in about 30 parts of cold water or alcohol. It is used as a local anesthetic like cocaine. Its advantages are that it is claimed to be less toxic than cocaine, solutions are more stable and may be sterilized by boiling. It has no effect upon the blood vessels, however, and is more liable to cause sloughing than cocaine.

Stovaine is a trade name for another synthetic preparation introduced to take the place of cocaine. Chemically it is benzoylethyldimethylaminopropanol hydrochloride. It occurs as small shining scales which are freely soluble in water or alcohol. Its solutions may be sterilized by boiling without suffering decomposition but are incompatible with alkalies and alkaloidal reagents. Stovaine is claimed to be as strong an anesthetic as cocaine and less toxic. It dilates the blood vessels. Stovaine may be used under the same conditions as cocaine but is too irritant for application to the eye and is more liable to cause sloughing at the point of injection. This drug has come into considerable prominence to produce sublumbar (intraspinal anesthesia).

Alypine is another substitute introduced as a local anesthetic. It is claimed to be equally active but less toxic than cocaine, causes no mydriasis, nor vaso-constriction (on the contrary vaso-dilatation), and its solutions resist boiling for from five to ten minutes without decomposition. Chemically it is benzoyldimethylaminomethyldimethylaminobutane hydrochloride. It occurs as a white chrystalline powder, freely soluble in water, alcohol and chloroform, and sparingly soluble in ether, yielding neutral solutions that may be sterilized by boiling for not more than five minutes. According to some authorities it will not stand boiling. Alypine is mostly employed in 2 to 4 per cent. solution.

Alypine Nitrate is introduced as an anesthetic that may be used with silver nitrate without fear of decomposition.

Quininæ et Ureæ Hydrochloridum U. S. P. (carbamidated quinine dihydrochloride). This preparation occurs as white, odorless, bitter crystals or white powder, soluble in about one part of water and freely soluble in alcohol. It contains 70 per cent. of quinine alkaloid. The anesthetic properties of quinine were discovered in using the drug hypodermically for malaria. It is used

as a local anesthetic in 2 to 4 per cent. solutions by injection and in 10—20 per cent. solutions for application to mucous membranes. It produces anesthesia much less rapidly than cocaine but on the other hand, the anesthesia is very persistent, lasting in some cases for several days. It is less toxic than cocaine and is said to be stable in solution. Some authorities claim that it dilates the vessels at the point of application.

Holocaine Hydrochloride (phenetidylacetphenetidin hydrochloride) occurs as a white, odorless, bitter powder, soluble in 50 parts of water and freely so in alcohol. This anesthetic is especially useful upon the eye. It paralyzes the sensory nerves more powerfully than cocaine and does not produce any necrosis. It is used in from ½ to 1 per cent. solution and may be sterilized by boiling, but does not influence the blood vessels. Anesthesia is produced very rapidly but is not lasting (produced in about one-half minute and lasts for 5 to 10 minutes). It is extremely sensitive to alkalies, hence its solutions should be made in porcelain capsules and kept in porcelain containers or in bottles that have been previously treated with hydrochloric or sulphuric acid (to remove the alkali present in the glass as far as possible) and thoroughly rinsed in distilled water; only distilled water should be used in making solutions.

Tropacocaine is obtained from the small Java Coca leaves. It resembles cocaine in its actions but is must less toxic and does not constrict the blood vessels when applied to mucous membranes or dilate the pupils. Its only advantages over cocaine are that it is less toxic and its solutions may be boiled.

Orthoform (the methyl ester of meta-amido-para-oxybenzoic acid) occurs as a white, bulky, odorless, tasteless powder, slightly soluble in water, soluble in 6 parts of alcohol, and 50 parts of ether; it dissolves readily also in collodion. It has the same action on the sensory nerves as cocaine but on account of its slight solubility and rapid excretion, toxic effects are not easily produced. On the other hand, if rendered soluble it is no less toxic than cocaine. It is prescribed as a local anesthetic and antiseptic in painful wounds, with caustics to relieve the pain, etc., in 5 to 20 per cent. ointments, paints, dusting powders or alone. Orthoform must be protected from the light, is incompatible with antipyrine, bismuth subnitrate, mercuric chloride, silver nitrate, zinc chloride and potassium permanganate.

Anesthesin (para-amidobenzoic acid ethyl ester) occurs as a white, odorless, tasteless powder, sparingly soluble in water, but readily soluble in alcohol, chloroform, ether, fats or oils. This preparation has been recommended to take the place of orthoform, as it is claimed to be stronger and less irritant. According to some authorities, however, it is more toxic and consequently more liable to produce systemic effects from its application. Its hydrochloride is soluble and may be used for subcutaneous anesthesia like cocaine.

Propesin (propyl ester of para-amidobenzoic acid) occurs as a white crystalline powder sparingly soluble in water. Its uses are identical with those of anesthesin.

Chloretone is a weak anesthetic and is not used to any extent for this purpose in veterinary medicine.

Dionin is soluble in 7 parts of water. It is used in 5 per cent. solution to dilate the pupil, lessen intraocular tension and abolish pain in the eye. It causes irritation and chemosis at first, which soon disappears. On account of its irritant action it is classed as a corneal lymphogogue and is useful in treating opacities of the cornea. It may be used in 5 to 10 per cent. solutions or dionin may be dusted in the eye. After several days, the eye becomes immune to the drug, so that it must be discontinued for a time.

Yohimbine is a local anesthetic when applied in 1—2 per cent. solution. The effects begin in 10 to 15 minutes and last ½—1¾ hours. The vessels are dilated even when used with adrenaline. It should not be used in the eye because it produces too much irritation. (See aphrodisiacs.)

Comparison of Cocaine and Its Substitutes.

The most valuable features of cocaine are its strong, prompt and quite certain action. It is also the best known of the group. It is a vasoconstrictor, lessens hemorrhage, may be of service as a mydriatic, causes no local irritation, and acts on sound mucous membranes.

The substitutes improve upon the older drug mainly by their lesser toxicity, do not injure the cornea, are more stable, sterilizable and antiseptic. Of the great number of substitutes, novocaine appears at the present time to be the most commendable; its feeble toxicity permits large amounts to be used without inconvenience; it has fairly strong anesthetic properties, is nonirritant, and not a vasodilator. Its only drawback is that its period of action is shorter than cocaine, but this can be overcome by the addition of a small amount of adrenaline solution. Reclus recommends the following solution:

Normal salt solution	100 mils
Novocaine	.05 (50 centigrams)
Adrenaline solution (1—1000)	25 drops

The following table of relative toxicity was arrived at by the Therapeutic Committee of the British Medical Association. Cocaine is taken as the standard of comparison and is represented by 1.

Alypine	1.25
Cocaine	1.00
Nirvanine	0.714
Stovaine	0.625
Tropococaine	0.500
Novocaine	0.490
Beta-eucaine lactate	0.414

Alypine often gives fine results in operations upon horses and is said to be less toxic to them, or at any rate, does not produce such symptoms of excitability, but it may be followed by swelling which may last for several days.

OTHER MEASURES FOR PRODUCING LOCAL ANESTHESIA

Atropine resembles cocaine somewhat but is much weaker in action, but on the other hand is more readily absorbed from the intact skin and may be used in liniments, ointments and plasters.

Aconite first stimulates and then depresses the sensory nerves without irritation.

Aromatic Series. Many of the members of the aromatic series possess an anesthetic action. This is particularly so of phenol, which produces marked anesthesia even in dilute solution. Its application, however, is often injurious, since it causes destruction of the skin and may be absorbed in sufficient amounts to produce toxic symptoms. It may be used for combined anesthetic and antiseptic action for such operations as hypodermic injections, paracentesis, etc., in which case the needle may be dipped in strong phenol, applied to the point of introduction for a moment, then followed by an application of alcohol to prevent serious destruction of tissue. All the bodies of this group show this double action. Acetanilid and antipyrine may be used as a dusting powder for the combined anesthetic and antiseptic action, but their action is not strong.

Application of Cold. This in addition to anesthetic action produces a local anemia. The anesthesia is complete but has the disadvantage of producing pain at first and may be followed by gangrene. This method of producing anesthesia is best done by spraying the surface with a highly volatile liquid, such as ethyl chloride or ether, but it may be produced in emergency by the application of salt and ice.

Counterirritants. These first produce stimulation and then depression of the nerves. Turpentine, menthol, camphor, alcohol, chloroform, and all essential oils.

Magnesium Salts. Meltzer and Auer (1905) discovered the anesthetic action of the magnesium salts. They found that the application of magnesium sulphate to nerve-trunks blocked conductivity and abolished reflex excitability. They also found that a general anesthesia, with abolition of the reflexes, may be produced by the subcutaneous injection of magnesium salts (1.5 gm. of crystallized magnesium sulphate per Kg. of body weight used as 25 per cent. solution). The same effect was produced when introduced intra-

venously, while the intracerebral injections produced a state of general inhibition. Both the intravenous and subcutaneous injections produced a complete muscular relaxation in tetanus, lasting often as long as twenty-four hours. Meltzer later used the intraspinal method (1 mil of a 25 per cent. solution to each 25 pounds of weight) for several operations and as a treatment for tetanus. In the latter condition, however, although the relaxation may last for as long as twenty-four hours, there was no effect upon the high temperature of this disease and the patients died from exhaustion, without there being any gain in the reduction of the mortality. This drug has never gained any prominence as a local or general anesthetic in veterinary medicine and is being discarded or superseded by other drugs in human medicine.

Menthol. Menthol is a stearopten obtained from oil of peppermint. It occurs in the form of colorless prismatic or acicular crystals, having a mint-like odor and taste. It is slightly soluble in water, but freely soluble in alcohol, ether and chloroform.

Doses. H. grs. vijss—xv; 0.5—1. D. gr. ss—ij; 0.03—0.13.

Action and Uses. Menthol is a local anesthetic and antiseptic. It liquefies when triturated with camphor, thymol or phenol.

It is used as a local anesthetic or anodyne and antiseptic in dusting powders, ointments or solutions. One part of menthol to ten of olive oil makes a useful application to burns. Internally it is a carminative and analgesic.

℞ Mentholi.
Eucalyptoli .....āā ʒ j
Alcoholis ..... ʒ ij
Liq. Cresolis Comp. ..... ʒ v
Aquæ q. s. .....ad. ℥ viij
M. Ft. Sol.
Sig. One-half ounce in hot water as an inhalant.

For Pruritis.
℞ Mentholi ..... ʒ j
Alcoholis q. s. .....ad. ℥ j
M. Ft. Sol.
Sig. Apply to parts as necessary.

Ointment for Pruritis.
℞ Mentholi ..... ʒ ij
Olei Olivæ ..... ℥ j
Petrolati q. s. .....ad. ℥ ij
M. Ft. Unguentum.
Sig. Apply as necessary.

DRUGS USED TO PARALYZE TASTE ORGANS

There are several drugs that paralyze taste which it seems well to describe here.

Gymnemic acid (from Gymnema sylvestris). Destroys bitter and sweet, not acid or salt.

Eriodictyon (Yerba santa), the leaves of *Eriodictyon glutinosum,* native to California. Destroys bitter taste; not sweet, acid or salt. The fluid extract is mostly used. One mil will cover the taste of 0.012 gm. of quinine sulphate or 1.5 gm. of quassia. It is probably therapeutically objectionable, because it may render alkaloids insoluble on account of the tannic acid it contains. Furthermore, it is believed that the action of bitters as such depends somewhat upon the bitter taste.

MOTOR NERVE DEPRESSANTS

A few drugs depress the peripheral nerves but are of more importance from the standpoint of toxicology than medicine. The most important are:

Hydrocyanic acid
Cyanides
Crude drugs from which hydrocyanic acid may be obtained
Wild Cherry and bitter almonds
Curare
Conium
Gelsemium
Lobelia
Tobacco

ACIDUM HYDROCYANICUM DILUTUM — DILUTE HYDROCYANIC ACID

Diluted prussic acid is an aqueous solution containing 2 per cent. by weight of absolute hydrocyanic acid. It should be kept in small bottles well protected from light in a cool place. Scheele's hydrocyanic acid contains about twice the amount of the official preparation.

Doses. Horses and Cattle. ♏ xx—℥j; 1.—4. Sheep. ♏ x—xv; 0.6—1. Dogs. ♏ j—iij; 0.06—0.2.

Action. Hydrocyanic acid is a protoplasmic poison. It paralyzes the sensory nerve endings, causing local anesthesia.

Digestive System. When administered in fairly strong concentration, hydrocyanic acid causes a feeling of burning in the mouth with a reflex increase of saliva, followed by numbness and

anesthesia. The same numbness is produced in the stomach and accounts for its sedative action in nausea.

Nervous System. The central nervous system is first stimulated and then depressed. The stimulation is especially marked in the medulla, so that the respiratory center, vasomotor and vagal centers are stimulated, resulting in an acceleration of the respiration, constriction of the blood vessels and slowing of the heart. The blood pressure rises on account of vasoconstriction in spite of the slowing of the heart, but soon falls on account of vasodilatation. The respirations are at first accelerated as stated above, but soon become slowed and shallow, death being due to asphyxia. The heart is depressed by large doses. Poisonous doses paralyze the central nervous system.

Metabolism. Hydrocyanic acid enters the blood very rapidly and while in the circulation profoundly affects metabolism, so that the tissues lose their power of absorbing oxygen. Contrary to previous belief it does not fix the oxygen more firmly to the hemoglobin, but the bright red color is due to the tissues which do not reduce the oxyhemoglobin (Dixon).

Absorption. Hydrocyanic acid is absorbed rapidly from the mouth or gastrointestinal tract, and may produce symptoms within a few seconds after its administration.

Toxicology. Hydrocyanic acid is one of the most rapid and fatal poisons. A large dose may cause death by paralysis of the cardiac and respiratory centers, but death is usually due to asphyxia.

Immediately after the administration of a fatal dose to dogs, the animals make a few gasping respirations, may cry out, go into convulsions and die in 2 or 3 minutes from respiratory paralysis. The heart continues to beat for a short time after the respirations cease. If death is somewhat delayed, the pupils dilate, there is incoordination, a weak pulse and convulsions. The fatal dose of diluted hydrocyanic acid for dogs is 40—60 minims, for horses, 4—5 drams (Hoare).

Autopsy. If an autopsy is performed quickly, the characteristic odor of the acid may be detected. The lesions are not constant. The blood may have a venous appearance if death has not taken place quickly, but if immediately, as after a large dose, may be bright red.

Treatment. Artificial respirations should be started early. On account of the rapid absorption and action, the choice of antidotes is difficult. Central nervous stimulants (atropine, strychnine) should be given hypodermically. Hydrogen peroxide is said to be antidotal and is easily obtained. Sollmann recommends sodium thiosulphate (hyposulphite) 100 mils (3 ounces) of a 3 per cent. solution subcutaneously (in man) to form the harmless sulphocyanide, but the action of prussic acid is generally so rapid that treatment is not successful.

Uses. Small doses are recommended to relieve nausea and vomiting in small animals. It acts through its anesthetic action and is not in any way superior to less dangerous remedies. It is usually prescribed with bismuth preparations for this action.

Cough. Hydrocyanic acid is sometimes used to allay cough in dogs with asthma or other diseases. It should be given in minim doses, frequently, and the patient should be closely watched. Morphine and its allies are just as serviceable and safer.

Chloroform Poisoning. Hobday recommends a full dose of hydrocyanic acid to be placed upon the tongue of dogs in case of accidents in chloroform anesthesia. Its benefit is probably due to a strong primary stimulation of the respiratory center together with the few deep inspirations which occur. Other measures should be kept up at the same time.

POTASSII CYANIDUM — POTASSIUM CYANIDE

Cyanide of Potassium

Doses. Horses. gr. j—ij; 0.06—0.12. Dogs. gr. ⅙; 0.01.

Action and Uses. Potassium cyanide is converted in the stomach and blood to hydrocyanic acid and resembles that drug in action. There are no internal or external uses of this drug, although it is sometimes used to destroy animals. Five grains have caused death in a man, 60—120 grains in horses, and it required 9 ounces to kill an elephant in Central Park.

Crude drugs from which hydrocyanic acid may be obtained:

Prunus Virginiana — Wild Cherry. The bark contains a glucoside, amygdalin, a ferment emulsin, a bitter principle and tannin. It does not contain prussic acid but when the glucoside amygdalin, is acted upon by the ferment in the presence of water, it splits up into hydrocyanic acid as one of the decomposition products. Thus it is necessary for the bark to be placed in contact with water for the production of the acid.

Preparations and Doses.

Infusum Pruni Virginianæ 4 per cent.	Not used.
Syrupus Pruni Virginianæ 15 per cent.	D. 3j; 4.0.
Fluidextractum Pruni Virginianæ.	D. ♏ xxx; 2.0.

Oleum Amygdali Amari. Oil of bitter almonds — contains the same glucoside and ferment as wild cherry and forms hydrocyanic acid in the same way. It is not used in veterinary medicine.

These preparations are not valuable remedies. The different preparations of wild cherry have been used as tonics on account of the bitter principle. The syrup is quite extensively used as a vehicle for cough remedies, but contains so small an amount of the acid that

it is in itself inert. Bitter almond oil is sometimes used as a flavor.

It is important to note in connection with these drugs that stock frequently become poisoned from eating the wilted leaves of wild cherry, due to the formation of hydrocyanic acid during the wilting process. Occasionally corn and sorghum stalks cause the same trouble.

CONIUM

Conium-spotted hemlock, "not hemlock," is the full-grown fruit of *Conium maculatum.* It contains the alkaloid coniine (conine).

Doses.

Coniinæ Hydrobromidum. H. grs. ¾—1½; 0.05—0.1. D. gr. 1/60—1/30; 0.001—0.002.

Conium is a motor depressant but its only interest from a practical standpoint is its toxicology, as animals may eat a sufficient amount of it to cause poisoning. The symptoms of poisoning are: dullness, loss of muscular power, especially of the posterior extremities, stumbling or falling. Salivation, nausea, dilatation of the pupils and convulsions may occur. The pulse becomes slow and feeble, breathing very shallow, and the surface of the body cold. Paralysis is so complete that the animal lies as helpless as though dead. In doubtful cases of poisoning, urine from a suspected animal may be injected into frogs and if the case is one of conium poisoning, the frogs will be afflicted in the same manner.

Treatment. Evacuate the stomach, administer tannic acid as the antidote, start artificial respiration, administer nerve stimulants (strychnine, etc.), keep the animal warm.

CURARE

Curare, a resinous extract containing the alkaloid, curarine, is a South American arrow poison, probably derived from various species of strychnos of South America.

Curare has no action when administered per os on account of its rapid elimination, but if it enters the circulatory system, through an open wound or from subcutaneous injection, it paralyzes the motor end plates in all striated muscle except the heart. It is not used in medicine.

LOBELIA

Synonym. Indian Tobacco

Lobelia is the dried leaves and tops of *Lobelia inflatus.* It contains a volatile liquid alkaloid, "lobeline," and resembles nicotine or tobacco in action.

Preparations and Doses.

Fluidextractum Lobeliæ. H. ʒj—viij; 4.—30. D. ♏ ss—xx; 0.03—1.3.

Tinctura Lobeliæ. H. ℥j—ij; 30.—60. D. ♏ iij—xxx; 0.2—1.3.

Action and Uses. Lobelia resembles nicotine and coniine in action, and causes death by respiratory paralysis. Lobelia is a strong gastric irritant and consequently is emetic. It depresses the peripheral vagus, like coniine, and relaxes the bronchioles. On account of its nauseant action it is an expectorant. Lobelia may be useful in asthma of dogs and heaves of horses and is frequently combined with belladonna in these cases. Some recommend 10 or 15 drops of the tincture every few minutes until vomition occurs in asthma of dogs. It acts in the above conditions probably by dilating the bronchioles. Lobelia is often prescribed as a sedative expectorant. The alkaloid lobeline has been recommended in the treatment of tetanus, but the results from its use are not encouraging.

GELSEMIUM

Synonym. Yellow Jasmine

Gelsemium is the roots of *Gelsemium sempervirens.* It contains two alkaloids, gelseminine, which forms amorphous salts and upon which the action of the crude drug depends, and gelsemine, which in large doses increases the spinal reflexes and later paralyzes the motor nerve endings. Commercial gelsemine is a mixture of both alkaloids but closely resembles gelseminine in action.

Preparations and Doses.

Fluidextractum Gelsemii. H. ʒj—ij; 4.—8. D. ♏ v—x; 0.3—0.6.

Tinctura Gelsemii. H. ℥ss—j; 15.—30. D. ♏ xv—ʒj; 1.—4.

Action and Uses. Gelsemium has an action similar to conium, but produces death by paralyzing the respiratory center instead of the peripheral nerve endings (Dixon).

Large doses accelerate the heart by paralysis of the vagus. When applied directly to the eye, gelsemium or its alkaloids dilate the pupils and paralyze the power of accommodation, much the same as atropine, but they cause some pain and the action is not as complete or as persistent. Gelsemium and its alkaloid gelseminine (gr. ss, every half hour) have been recommended in the treatment for spinal meningitis and tetanus, but there are probably no therapeutic indications for the drug that cannot be better treated with other agents.

TOBACUM — TOBACCO

Tobacco is the leaves of *Nicotiana tobacum*, subjected to a process of fermentation to remove certain proteins and fats that make the smoke disagreeable and then to a second fermentation during which a considerable amount of nicotine is lost and aroma developed. It contains a liquid, oily, volatile alkaloid nicotine, allied alkaloids and a volatile oil, to which its aroma is due.

Action. Tobacco has an action similar to conium, but has less effect upon the motor nerve endings. Its most important action is upon the sympathetic nerve cells which are at first stimulated, then depressed and finally paralyzed (Dixon).

Externally and Locally. Tobacco is an antiseptic and parasiticide.

Digestive System. Tobacco or nicotine is a gastrointestinal irritant. It increases the secretion of saliva from irritation of the drug in the mouth. It causes nausea, vomiting and increased peristalsis either from direct irritation or after absorption. Toxic doses cause the usual symptoms of gastro-enteritis.

Circulatory System. The heart is first slowed through stimulation of the vagus center and ganglia and then accelerated through depression of the vagus center and stimulation of the sympathetic ganglia. The final result is always an acceleration of the pulse due to a lack of inhibition. Blood pressure is increased for a short time on account of stimulation of the vasoconstrictor center and intense stimulation of the cells of the sympathetic ganglia, but is soon followed by a fall in pressure, due to a depression of the same structures. All these actions finally result in vasodilation, fall of blood pressure and acceleration of the heart.

Respiratory System. The respiratory center is first stimulated, then depressed and finally paralyzed by large doses.

Nervous System. Nicotine first stimulates the central nervous system, but this soon gives way to depression. There is no marked action upon the brain. Its action upon the medulla is shown through its action upon the various centers. These are first stimulated and then depressed. The cord is not so strongly influenced as the medulla but there is a transitory stimulation of the reflex centers, causing twitching, convulsions, etc., soon giving way to depression and, in toxic doses, paralysis. All sympathetic ganglia are briefly stimulated, then depressed.

Eye. The action of nicotine upon the pupils is not constant. In the dog and cat it is dilated for a brief period, constricted in the rabbit and in man constricted at first, then followed by dilatation. The difference probably depends upon whether the sympathetic (dilator) or occulomotor (constrictor) ganglia are affected.

Glands. The secretions from the salivary, sweat and bronchial

glands are at first increased due to action upon the ganglion cells in secretory nerves. Large doses stop all secretions through paralysis of the same ganglia.

Absorption and Excretion. Nicotine is rapidly absorbed. Sufficient may be absorbed from the skin to produce toxic symtoms in some animals. It is largely excreted through the kidneys, although some is probably thrown off through the sweat and other glands, and some is probably destroyed in the tissues.

Toxicology. Nicotine is one of our strongest poisons. Two drops placed on the tongue or rubbed into the gums of a small dog or cat will cause death in a minute or two, 10 drops have killed a large mastiff almost immediately. The fatal dose for horses is given at 10 drops of nicotine or ½ pound of tobacco.

When taken per os nicotine causes irritation to the mouth, throat and stomach with pain, nausea, vomiting (in some animals) and purging. Tremors and clonic spasms of the muscles occur followed by depression and paralysis. The respirations are slow and weak, pulse rapid. The animal may go into collapse.

Treatment. Evacuate the stomach and administer cardiac and respiratory stimulants hypodermically, strychnine, alcohol, atropine, and administer tannic acid per os as the chemical antidote.

Uses. Tobacco is not a very useful therapeutic agent. Its greatest use is probably as a parasiticide in mange of animals, especially sheep scab, although it is a very efficient parasiticide for lice, fleas, etc., of the large animals. As it is absorbed from the skin, larger amounts than can be given per os should not be applied. For mange of sheep and other animals, it is used in decoctions (2—5 per cent.) to which a definite amount of caustic potash or soda and carbolic acid have been added. The Prussian Government recommends the following: Boil 7½ kilograms of native grown tobacco with 50 liters of water for one half hour, strain, add 1 kilogram of liquid carbolic acid, and 1 kilogram of caustic potash and enough water to make the mixture measure 250 liters. Use at a temperature of 35° C. and the sheep should be kept in for two minutes. Then work the surface of the body for two minutes more, after taking from the dip.

Law's dip is as follows: Tobacco 16 pounds, oil of tar 3 pints, soda ash 20 pounds, soft soap 4 pounds, water 50 gallons. Sufficient for 50 sheep. Steep the tobacco for one-half hour, strain and add the other ingredients at 70° F.

Tobacco is not used internally in this country, but has been used in Germany as a ruminatorium for cattle in doses of 2 ounces (30.0 gm.) with one-half pound of salt and one pound of Glauber's salts.

SPARTEINE

Sparteine is obtained from *Cytisus scoparius,* or broom tops. It resembles coniine in action but is much less toxic. It differs from

coniine in having but little action upon the central nervous system. Large doses paralyze the sympathetic nerves and the end plates of motor nerves. It causes death by paralyzing the nerve endings of the phrenics. Sparteine is more fully discussed under diuretics. See p. 295.

B. PERIPHERAL NERVE STIMULANTS

This group is made up of a few drugs which act almost exactly opposite to atropine. The chief members are

Physostigma Pilocarpus Arecoline

PHYSOSTIGMA

Synonyms. Calabar Bean, Ordeal Bean

Parts Used. The ripe seed of *Physostigma venenosum,* yielding when assayed, not less than 0.15 per cent. of the alkaloids of physostigma. The plant is indigenous to western Africa, and the beans were used by the medicine men for "trial by ordeal," hence the name "Ordeal Bean." The person accused of crime was given a paste made of the seeds; if he survived, he was considered innocent; if he died he was guilty. Tradition says that the priests "could be fixed" for a consideration, so that they would mistake harmless seeds for the true ones in making the paste.

Constituents. Physostigma contains the following alkaloids: physostigmine or eserine, which is the principal one; calabarine, to which it owes its tetanizing power; and eseridine, a laxative and motor excitant.

Preparations and Doses.

Extractum Physostigmatis. H. gr. iij—viij; 0.2—0.5. D. gr. $\frac{1}{10}$—$\frac{1}{2}$; 0.006—0.03.

Tinctura Physostigmatis, 15 per cent. H. ʒij—vj; 8.—25. D. ♏ij—xx; 0.13—1.3.

Physostigmine salicylate and physostigmine sulphate are the salts used. The former is soluble in 72 parts of water and 13, of alcohol; the latter is deliquescent and freely soluble in water and alcohol. Physostigmine or its salts decompose by light, heat and air, so that they are not suitable for hypodermic tablets, but should be purchased in hermetically sealed tubes. Solutions of this alkaloid turn a reddish purple color which indicates deterioration. The salicylate is more stable than the sulphate.

Physostigminæ Sulphas or Salicylas. H. gr. ss—iij; 0.03—0.2. D. gr. $\frac{1}{100}$—$\frac{1}{30}$; 0.006—.002.

Action. Eserine or physostigmine stimulates the secretory nerve endings of glands and of smooth and striated muscles. It, therefore, antagonizes the action of atropine upon secretions, the eye, and upon smooth muscle. It also antagonizes the action of curare on striated muscle. Eserine does not affect sensory nerve endings.

External and Local Action. There is no action except when applied to the eye.

Digestive System. Eserine stimulates the nerve endings in the muscles of the bowels and probably the muscle itself and produces severe peristalsis. It also stimulates the glands and increases the secretion of saliva, gastric juice, and intestinal secretions, but is not used as a stimulant to secretions because by constricting the arterioles and cutting off the blood supply, the secretion is limited. The peristalsis is not a regular one, but consists of a fixed tetanic ring (spasm) which causes griping.

Nervous System. The higher cerebral centers are not affected, since consciousness remains to the end. The vital medullary centers are first stimulated, then depressed. The reflexes are depressed, and in poisoning there may be ascending paralysis beginning in the extremities.

Respiratory System. Small doses may stimulate the respirations, but they are not usually affected. Larger doses depress the respiratory center, stimulate the endings of the pulmonary vagi and constrict the caliber of the bronchial tubes to a dangerous extent (dyspnea). The breathing is retarded with large doses, the effect being more marked upon this system than upon the circulation. Death is usually due to paralysis of the respiratory center.

Eye. When applied locally or given internally physostigmine contracts the pupils, causes spasm of accommodation and lowers intraocular tension. These actions are mainly due to the stimulation of the ocular motor endings in the iris and ciliary muscle and stimulation of the muscles themselves. The effects of eserine can be counteracted by atropine and vice versa; but the latter requires large doses and is not so easily accomplished.

Circulation. Small therapeutic doses do not affect the circulation. Moderate doses slow and strengthen the heart probably by direct action on the cardiac muscle. Although the effect of the drug on the heart has not been well worked out, it appears that the heart is depressed under large or toxic doses. Moderate doses produce a marked increase in blood pressure on account of constriction of the arteries from direct stimulation of the arterial muscles and partly by driving the blood from the splanchnic area by constricting the intestines. In toxic doses the rise in blood pressure is soon followed by a fall due to paralysis of the vasomotor center and weak heart. The heart is finally stopped in diastole.

Secretions. All secretions, especially the sweat, tears, saliva,

mucus, pancreatic and bile, are increased by stimulation of the nerve endings in the glands. This action may be counteracted by atropine.

Unstriped Muscle. Eserine tends to cause contractions of the unstriped muscle of the uterus, intestines, bladder, ureters and bronchi.

Toxicology. The symptoms are: muscular weakness without loss of consciousness, contracted pupils, diarrhea, vomiting. The heart is first slow and the blood pressure good, later the heart is weak and pressure lowered. The respirations are first rapid and deep, then become shallow and labored. (Cases of heaves particularly show great dyspnea.)

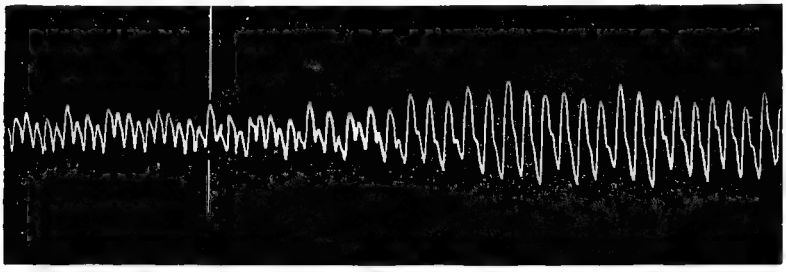

FIG. 18.

Blood pressure tracing. Cow. Effect of eserine upon the heart. (Tracing made by Dr. P. A. Fish.)

Treatment. Atropine is the best antidote for respiratory and digestive symptoms. But treat collapse if necessary.

Therapeutics.

1. As a myotic. For this purpose it is employed in ½ to 1 per cent. solution to counteract the action of atropine, or alternately with atropine to break up and prevent adhesions of the iris.

2. Stimulate involuntary muscle, as in impaction of the bowels to produce peristalsis. Usually given with pilocarpine to help stimulate secretions.

Colic. Horse.

℞ Physostigminæ Sulphatis ..... grs. j
Pilocarpinæ Hydrochloridi ..... grs. iij
Aquæ q. s. .....ad. ℥ j
M. Ft. Solutio.
Sig. For hypodermic injection.

Physostigmine is also useful in atonic conditions of the stomach and bowels and chronic intestinal catarrh in small repeated doses.

Contraindications.

1. In impactions and overdistentions of the stomach and intes-

tines with undigested food on account of the liability to rupture the walls by the violent peristalsis. It is used by some, however, in these cases with reported good results.

2. In spasmodic colic, because it increases the convulsive contractions of the bowels, consequently the pain is increased. There may be some danger of causing twist of the bowels, according to some authorities.

3. In pregnant animals there is danger of producing abortion.

4. In tympanies and chronic indigestion in cattle, eserine is not recommended by some, though it is usually considered a safe and efficient remedy in acute tympany.

PILOCARPUS

Synonym. Jaborandi

Parts Used. The leaflets of *Pilocarpus Jaborandi* or of *Pilocarpus microphyllus* yielding when assayed not less than 0.6 per cent. of alkaloids of pilocarpus. It is a shrub of Brazil.

Constituents. The leaves contain the alkaloids, pilocarpine, isopilocarpine, pilocarpidine, with similar action, and jaborine, which has an atropine-like action but is in too minute a quantity to have any effect. The first is the only one of importance.

Preparations and Doses.

Fluidextractum Pilocarpi. H. 3ij—iv; 8—16. D. ♏ v—3j; 0.3—4.

Pilocarpinæ Hydrochloridum, soluble in water and alcohol. H. grs. j—v; 0.65—0.3. D. grs. 1/10—1/3; 0.006—0.02.

Pilocarpinæ Nitras, soluble in water, less so in alcohol. Doses.—Same as of the hydrochloride.

Action. Pilocarpine antagonizes the action of atropine upon the ends of the secretory nerves, ends of nerves in plain muscle, ends of vagi and end of the third muscle in the internal eye. It does not affect the sensory nerve endings or the striated muscles or their nerve endings.

Digestive System. There is stimulation of all those structures depressed by atropine. Thus there is an increase in the secretions of saliva, gastric juice and probably intestinal juices, due to stimulation of the secretory nerve endings in the glands involved. Smooth muscle is not so easily affected except after large doses, in which case peristalsis is increased by stimulation of the nerve endings in the smooth muscles of the digestive tract. In large doses it serves as a rapid-acting cathartic.

Nervous System. There is no effect in moderate doses except stimulation of the peripheral nerve endings. Large doses act similarly to eserine.

Muscles. Pilocarpine contracts most of the plain muscles of the

body on account of stimulation of their motor nerve endings. Thus we have contraction of the plain muscles of the digestive tract, bladder, bronchi and ciliary muscle.

Circulation. The effects of the drug on this system are complex and vary somewhat on the different species of animals. The primary effect of the drug is to stimulate the cardiac terminations of the vagus and slow the heart. This is followed by paralysis of the vagus with rapid pulse from large doses. Later the heart becomes depressed giving a slow, weak pulse, due to weakness of that organ and depression of the vasomotor center. Finally the heart is paralyzed. After toxic doses the arterioles are dilated by depression of the vasomotor center and blood pressure falls.

Pilocarpine must therefore be regarded as a cardiac depressant, acting both upon the vagus and directly upon the heart, and in excessive doses is a vasodilator. Its margin of safety is small and it should not be used in cardiac weakness.

Respiratory System. The secretions of the bronchi are increased; the bronchi are contracted on account of stimulation of their nerve endings. On account of these actions the breathing in poisoning may be labored or asthmatic. Horses affected with heaves have dyspnea after moderate doses. On account of these factors, together with a weak circulation, death may take place from edema of the lungs, asphyxia or collapse.

Temperature. The temperature may be lowered if profuse sweating takes place. This is especially so in febrile conditions.

Secretions. Besides the secretions mentioned above, pilocarpine increases the secretion of mucus, tears and sweat. In man there is a very profuse secretion of sweat but this is not seen in the lower animals. In the horse the skin may become moist, but the salivary secretion is very profuse. It will take place in from 5 to 10 minutes after the hypodermic administration of a therapeutic dose and persists for ½ to 2 hours. Salivation is accompanied by clamping of the jaws and movements of the tongue.

Hair. The hair sometimes increases after local application or internal administration of pilocarpine.

Eye. Applied locally pilocarpine contracts the pupil by stimulation of the endings of the oculomotor nerve in the iris and lessens intraocular pressure. The eye is fixed in accommodation for near objects.

Therapeutics.

1. To increase secretions of the gastrointestinal tract, combined with eserine, as in obstinate constipation or impactions in horses or cattle.

2. Direct antidote to atropine and should be given in doses four times as great as the atropine.

3. May be substituted for eserine for action on the eye (½ per cent.).

4. Diaphoretic.

5. To remove waste matter from the blood and in cardiac dropsy. It is not very effective in these conditions of the lower animals, because the secretion of sweat is not greatly increased as in man.

6. The fluid extract is added to hair tonics to stimulate the growth of hair.

Contraindications.

1. It should not be given to animals suffering with heart or lung disease.

2. In colic where the heart is weak.

3. It is contraindicated in pharyngitis or tetanus because the animal cannot swallow easily and may drown in the saliva.

4. May produce abortion in pregnancy.

ARECOLINÆ HYDROBROMIDUM

Arecoline is the most important alkaloid of Areca Nut. See p. 279.

Doses. Horse and Cow. gr. ss—jss; 0.03—0.07 subcutem. Repeated once or twice at 15—30 minute intervals. Dog. $\frac{1}{12}$—1 gr.; 0.005—0.065 per os.

Externally and Locally. There is no action.

Digestive System. It is a strong stimulant to peristalsis and secretions, combining the action of eserine and pilocarpine. Feces are discharged in from 15 to 30 minutes after its administration. Arecoline is a much stronger sialagogue for the horse than pilocarpine. Salivation is noticed about 5 minutes after its subcutaneous injection, reaches its height in about 30 minutes, and continues to flow for about one hour. During this period the horse champs his jaws and appears as though greatly annoyed by the excessive secretion, which is so profuse that at times it may run from the mouth in large quantities. The secretions from the intestines are also increased.

Arecoline increases peristalsis by stimulating the nerve centers in the plain muscle of the intestines. This is not simply an increase in the normal movements of the intestines but consists of a firm tetanic contraction. This strong peristalsis causes a mild degree of colic throughout the period of action of the drug and in cases already suffering from abdominal pain the symptoms are always aggravated for a short time. It is necessary to keep this action in mind, as it always occurs but is not sufficient cause for alarm.

Anthelmintic Action. There is some difference of opinion as

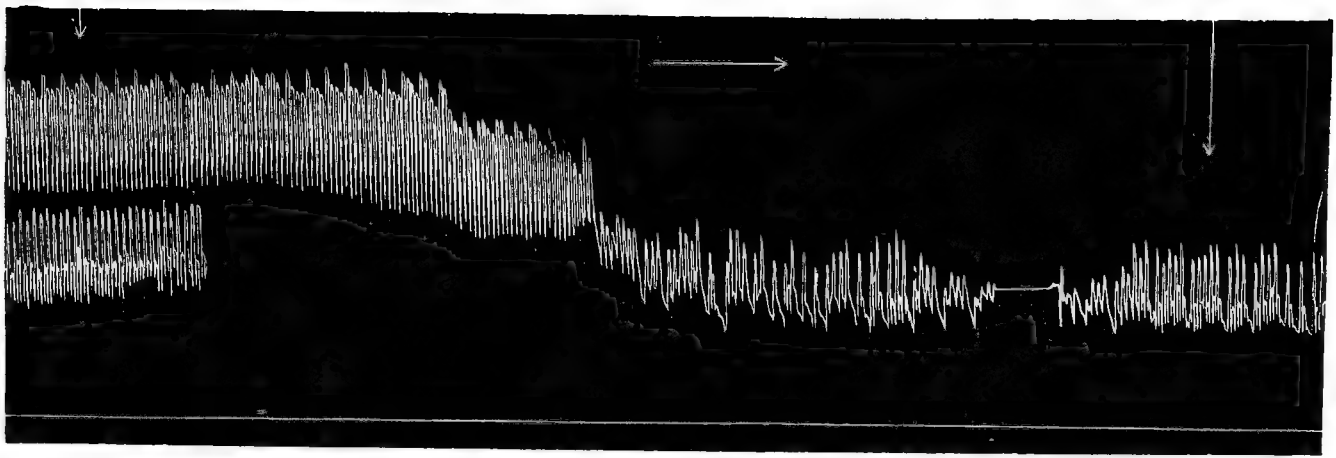

FIG. 19. Horse.

Blood pressure tracing after injection of 1 grain of arecoline hydrobromide subcutaneously. The short vertical arrow at the left indicates when the injection was made. The longer arrow at the right shows when ammonia vapor was inhaled. The lower tracing at the left shows the improved conditions of the heart beat after ammonia. (Tracing made by Dr. P. A. Fish.)

to its anthelmintic properties. Some claim that it is a vermicide for both tape and round worms and recommend it per os for dogs affected by these parasites. I have injected a solution of the drug into a loop of the intestines and after several minutes found living tapeworms in the loop. It frequently expels worms, however, but whether this is due to active peristalsis or direct action upon the parasites is not clear.

Respiratory System. Moderate doses slow the respirations by stimulating the vagus. The caliber of the bronchi is reduced by stimulation of the nerve endings of their plain muscles. Dyspnea results and is particularly marked if the animal is affected with heaves or other respiratory trouble. In such cases the symptoms may be dangerously aggravated. Large doses produce death by respiratory paralysis.

Circulatory System. Arecoline is a distinct depressant to the circulatory system. Moderate or therapeutic doses slow the pulse by stimulation of the vagus and lower blood pressure. Toxic doses produce arythmia of the heart, great fall in blood pressure and acceleration of the heart. The last mentioned condition is due to vagus paralysis. The heart usually continues to beat after the respirations cease.

Secretions. These are in general increased, due to a stimulation of the nerve endings in the glands. The sweat, urine, nasal and bronchial secretions are increased together with those of the digestive tract.

Eye. Local applications are followed by an increase of tears, spasm of the lids and some hyperemia of the bulb. This is soon followed by a constriction of the pupil, which begins in about 5 minutes after its application, reaches its minimum in 10 minutes and after about 10 more begins to dilate and returns to normal in about 70 minutes. This action is not seen after the internal use of the drug and in the dog I have seen widely dilated pupils from large subcutaneous doses.

Toxicology. Fröhner gives the toxic dose for the horse at 3—4 grains and the fatal dose at 7½ grains, but the author had one horse recover from 10 grains. In this case, however, antidotal doses of atropine were given immediately after salivation began. In a few experiments made upon dogs it appeared that after previous injections of small doses, the fatal dose was thereby apparently increased.

The symptoms of poisoning are: slow, weak pulse; marked fall in blood pressure, marked salivation, cyanosis, sweating, slowed and shallow respirations and dyspnea and collapse with a fast arythmic pulse. The antidote is atropine, which paralyzes those structures stimulated by arecoline. This should be given subcutaneously. Atropine should not be administered with arecoline, because in this case the period of action of arecoline is too short to be of any benefit.

Therapeutics. 1. *As a cathartic for all those conditions in horses requiring a rapid evacuation of the bowels: colic, impactions, etc.* It is often useful to stimulate contractions of the rumen in cattle. It is equal if not superior to eserine or pilocarpine or a combination of these drugs for this purpose. It can be given in small doses repeated once or twice at 15 to 30 minute intervals.

2. *As a specific for laminitis in the horse.* In this disease it has given especially good results. The animals are usually able to return

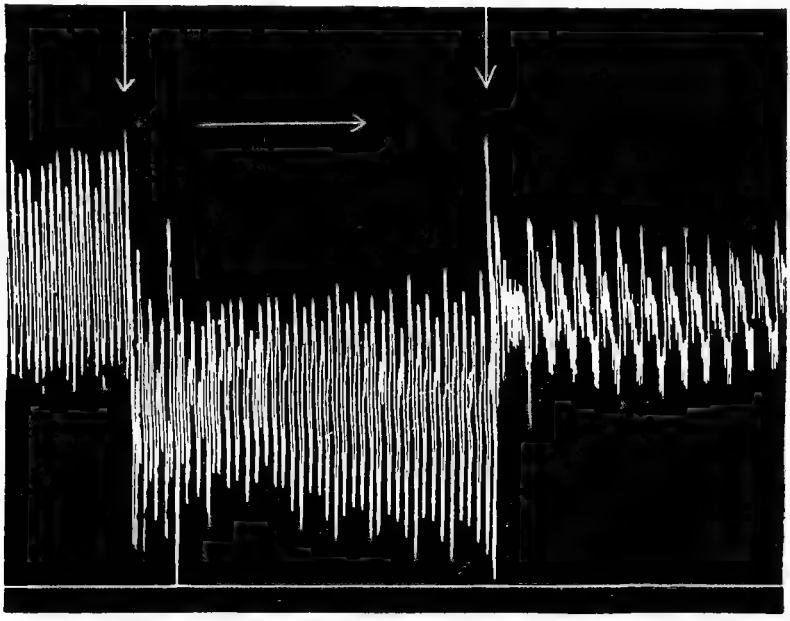

FIG. 20. Arecoline and Atropine.

Horse. The short tracing to the left is the normal. The left vertical arrow shows when the arecoline was injected. Note the fall in blood pressure. The second vertical shows when the atropine sulphate was injected. Note the rise of blood pressure and more rapid heart beat. (Tracing made by Dr. P. A. Fish.)

to work much sooner than under any other treatment. It should be given in daily doses or twice daily (morning and night) of ½—1 grain along with other treatment.

3. *In azoturia.* Some clinicians report good results from the use of this drug in azoturia. It is not to be regarded as a specific but as a rapid eliminant or cathartic. Other treatment should not be neglected.

4. *Myotic.* Solutions of ½ to 1 per cent. may be used as a myotic to counteract the action of atropine or to use alternately with atropine in iritis to prevent or break up adhesions of the iris. It may

be used as a substitute for eserine or pilocarpine for these conditions.

Contraindications. Arecoline is contraindicated in old debilitated animals, those with a weak heart, in nervous (spasmodic) colic, pharyngitis, diseases of the respiratory tract and in pregnancy. It should be administered to cattle with caution.

MYDRIATICS

Mydriatics are agents which dilate the pupil. The size of the pupil is regulated by two sets of muscles in the iris, circular which contract the pupil and radiating, which dilate it. The circular muscle is supplied with the third cranial nerve and the radiating by a branch of the sympathetic. Mydriasis may be brought about in any of the following ways:

1. Stimulation of the sympathetic center.
2. Stimulation of the peripheral fibers of the sympathetic in the radiating muscle.
3. Stimulation of the radiating muscle itself.
4. Paralysis of the oculomotor center.
5. Paralysis of the endings of the oculomotor nerve in the circular muscle.
6. Paralysis of the circular muscle itself.

Mydriatics interfere with the power of accommodation by a paresis of the ciliary muscle. Atropine, hyoscyamine and hyoscine are most powerful in this respect, while cocaine and euphthalmine are least so. Intra-ocular tension is increased, probably on account of the narrowing of the angle between the iris and cornea, thus hindering the escape of the humor through the canal of Schlemm or by blocking the efferent lymph vessels. Cocaine and euphthalmine are least active in this respect.

Therapeutics.

1. Facilitate examination of the interior of the eye.
2. Paralyze accommodation in examination for refractive errors in human medicine.
3. Prevent and break down adhesions of the iris.
4. Rest the iris.
5. Enlarge field of vision, where there is nuclear cataract with clear periphery of the lens.
6. Allay irritation in inflammation of the cornea.

The most important mydriatics are:

Atropine
Homatropine
Methylatropin (Eumydrin)
Hyoscyine or Scapolomine
Hyoscyamine
Cocaine
Euphthalmine

Atropine. Atropine causes mydriasis by paralyzing the nerve endings of the oculomotor nerve and destroys accommodation by paralysis of the nerve ends in the ciliary muscle. Intraocular tension is also increased. With a solution of 4 gr. to 1 ounce of water (practically 1 per cent.), mydriasis will begin in from 15 to 20 minutes, reach its maximum in one-half hour, and persist for 8 to 10 days. Loss of accommodation is not produced so quickly and is less persistent than mydriasis.

Therapeutics.

1. Atropine may be used as a simple mydriatic for examination of the interior of the eye, but for this purpose euphthalmine, cocaine and homatropine are just as serviceable and less disagreeable because their action is less persistent.

2. It is valuable to paralyze accommodation for refractive work (in man), but others of less persistent action are often preferred.

3. It is unequaled in iritis to break down and prevent adhesions between the capsule and lens.

4. It is useful in acute keratitis to allay ciliary irritation.

Strengths of Solution. As a mydriatic use one fourth grain to ounce of water, in iritis four grains to the ounce and keratitis one-half grain to the ounce.

Homatropine. This is an artificial alkaloid of atropine. The hydrobromide is the salt most used and is freely soluble in water.

Its action is similar to atropine but does not last more than two or three days. Stronger solutions are required than in the case of atropine, a solution of 8 to 12 grains to the ounce being required to paralyze accommodation. For examination of the interior of the eye a solution of one-half grain to the ounce is sufficient. Homatropine is expensive and rarely used in veterinary medicine.

Methyl Atropine or eumydrin is similar in action to atropine but is less toxic, more prompt and less persistent. Used in 1 to 2 per cent. solution.

Hyoscyamine. Very similar to atropine but less persistent. Use 2 grains to the ounce.

Hyoscine or Scapolamine is more powerful and less persistent than atropine.

Cocaine Hydrochloride. A four per cent. solution will produce complete anesthesia and mydriasis in 15 minutes. The mydriasis will reach its maximum in about one hour and last for 10 to 12 hours. The action is due to peripheral origin. Accommodation is but slightly impaired. On account of its prompt and short action, and because it so slightly disturbs accommodation, it is very suitable for examination of the interior of the eye. In cases of iritis, however, atropine is to be recommended for just the opposite reasons. Cocaine mydriasis may be easily overcome by a one per cent. solu-

tion of eserine. It is used in 4 per cent. solution. Stronger solutions are said to irritate the cornea.

Euphthalmine. This is a synthetic alkaloid derived from B. Eucaine. It is soluble in cold water, staple in solution and may be sterilized by boiling. After the installation of a few drops of a 4 per cent. solution, mydriasis takes place in a few minutes, reaches its maximum in one-half hour, and lasts but a few hours. Accommodation is not affected to any great extent. This drug is not irritant to the cornea or conjunctiva, causes no systemic disturbances, but does increase intraocular pressure. Since it interferes with accommodation so slightly, it is recommended for examination of the interior of the eye. A 4 to 6 per cent. solution is usually employed.

MYOTICS

Myotics are drugs that contract the pupil. Myosis or contraction of the pupil may be produced by conditions exactly opposite to those of mydriasis. Pilocarpine and eserine applied locally contract the pupil by stimulation of the circular muscle of the iris, or by stimulation of the peripheral endings of the oculomotor nerve in this muscle. Myotics lessen intraocular pressure by bringing about conditions exactly opposite to those produced by the action of mydriatics. Strong solutions of the myotics may bring about spasm of the iris. Most important of myotics are:

Physostigmine Pilocarpine Arecoline

Physostigmine and Pilocarpine (*Physostigmine* or *eserine*) is the one used most. A solution of one-eighth to one grain to the ounce of water is sufficient for mild continuous action, but stronger solutions (2 to 3 gr. to the ounce) are required where prompt action is needed. Eserine produces its maximum effect in less than an hour (30 to 40 minutes) and may persist several days. It is not staple in solution or in tablet form. This is its chief disadvantage. *Pilocarpine* is similar in action to eserine but weaker. Usually employed in solution of 1 to 4 grains to the ounce.

Arecoline Hydrobromide. This is a powerful myotic applied locally, but causes mydriasis if given internally. Myosis starts within a few minutes and is complete in about 15 minutes after installation of a few drops of a solution of 2 to 5 grains to the ounce. It may also produce spasm of the iris. Its chief advantage is that solutions are staple. In comparison to eserine its action is more prompt but less persistent.

CHAPTER XI

SPECIFICS FOR THE ALIMENTARY TRACT

1. STOMACHICS — BITTERS

Stomachics are drugs used to increase the appetite and promote the functional activity of the stomach. They are characterized by a markedly sharp taste, either bitter or aromatic. If a bitter also contains a volatile oil or a resinous aromatic principle, it is called an "aromatic bitter," while if it contains tannin, it is called an "astringent bitter." The following are the more important members of the different groups:

Simple	*Aromatic*	*Astringent*
Gentian	Calamus	Cinchona
Quassia	Aurantii Amari Cortex	Cascarilla
Calumba	Absinthum	Serpentaria
Taraxacum	Humulus	Condurando
Nux Vomica	Panax (Genseng)	Cimicifuga
Chirata		Cuspariæ Cortex

It is not definitely known how bitters produce their action upon the stomach, although it is probably due to a peculiar irritation of the gastric mucosa, producing a reflex flow of all the digestive fluids together with a hyperemia of the mucosa and increase in peristalsis. The increased appetite is probably due to a stimulation of the nerve endings in the taste buds involved in the sensation of hunger (gustatory). With the exception of nux vomica and chinchona, bitters have no direct action beyond the digestive tract.

General Uses.

1. To modify or improve the taste of food or medicine.
2. To stimulate the appetite.
3. To increase digestion in atonic conditions when the stomach is not irritable.
4. Antemetic.

Contraindications. In all conditions where there is marked irritability or hyperemia of the stomach. If the appetite is normal, bitters may not increase but lessen it.

Administration. The best results are obtained by giving bitters in liquid form ½ hour before feeding. It has been shown by experimentation on the dog that an increased action of the organs is obtained from bitters in from 20 minutes to ½ hour after administra-

tion, while their immediate action is not marked. Other investigators claim that there is no action from bitters and that their use is very much overestimated. The tannin of the astringent bitters may be useful in catarrhal conditions and subacute or chronic inflammations, but in most cases it is not so. Furthermore the astringent bitters are not compatible with preparations of iron because they contain tannin.

GENTIANA — GENTIAN

Gentian is the root of *Gentiana lutea.*

Preparations and Doses.

Fluidextractum Gentianæ. H. and C. ℥ss—j; 15—30. Sheep and Swine, ʒj—ij; 4.—8. D. ♏ v—xxx; 0.3—2.

Gentiana. Same as the fluidextract.

Tinctura Gentianæ. Not used in large animals. Dogs. ʒj—iv; 4.—15.

Tinctura Gentianæ Compositæ. Same dose as for the tincture.

Action and Uses. Gentian is a simple bitter and has no action beyond the digestive tract. It is probably the most reliable and most used bitter for the large animals. It is indicated in convalescence from febrile disease and in other conditions where a bitter tonic is desired. Since it contains but a small amount of tannin it may be and frequently is prescribed with iron as a tonic for large animals.

Tonic for Horses and Cattle.

℞ Gentianæ ..... ℥ iv
Nucis Vomicæ ..... ʒ iv
Sodii Bicarbonatis ..... ℥ iv
Zingiberis ..... ℥ iv
M. Ft. Pulveres No. 8.
Sig. One, three times daily on feed.

QUASSIA

Quassia is the wood of a tree *Picrasma excelsa.*

Preparations and Doses.

**Extractum Quassiæ.* H. ʒj—ij; 4.—8. D. gr. j—iij; 0.03—0.2.

**Fluidextractum Quassiæ.* H. ℥j—ij; 30—60. D. ♏ xv—lx; 1—4.

Tinctura Quassiæ. H. ij—iv; 60—120. D. ʒss—ij; 2—8.

Quassiin (a bitter principle). H. Not used. D. gr ⅛—⅓; 0.008—0.02.

Action and Uses. Besides having the action of a bitter, quassia is a vermicide for seat or pin worms. It is used in the same class

* Unofficial.

of conditions as gentian for its bitter action and an infusion is used as an enema to remove *oxyures* or pin worms. Quassia does not contain tannin and may therefore be prescribed with preparations of iron. The infusion (℥ij—O.j) injected into the previously emptied rectum is one of the best agents to remove the different oxyures.

Nux Vomica. This is of more use than the other bitters because it has a decided stimulant or tonic action upon peristalsis. It is very useful in chronic indigestion and loss of appetite accompanied by but little irritation.

Cinchona and Quinine. These are general tonics as well as bitters. During convalescence the best preparation of cinchona is probably the compound tincture. Indigestion from exhaustion is frequently benefited by a combination of quinine and nux vomica as in the following prescription:

Tonic for Dogs.

℞ Quininæ Sulphatis ..... gr. x
Ferri Sulphatis Exsiccati ..... gr. xx
Ext. Nucis Vomicæ ..... gr. ij
M. Fiant Pilulæ No. 20.
Sig. One after each meal.

The other members mentioned in the group have no decided advantage over those discussed. They are:

Taraxacum — Dandelion.
Xanthoxylon — Prickly ash.
Cascarilla.
Serpentaria — Virginia snake root.
Cimicifuga — Black snake root.
Calamus — Sweet flag.
Humulus — Hops.
Aurantii Amari Cortex — Bitter orange peel.

There are also many more which might be included in the list but they are not used to any extent in Veterinary Medicine.

2. GASTRIC ANTACIDS

These are drugs used to neutralize the acidity of the contents of the stomach. Some of them, like sodium bicarbonate, have an additional property of neutralizing the urine, while others have no such action. These agents are used 1. To neutralize the organic acids; lactic, butyric and acetic, caused by the fermentation of food stuff and which cause eructations and gastralgia. 2. To lessen acidity in hyperchlorhydria (excess of gastric hydrochloric acid) and 3. Antidote for acid poisons.

It was formerly believed that the administration of alkalies and the alkaline carbonates before meals stimulated the secretion of the

gastric juice, but this has been proven erroneous and their only use is to neutralize hyperacidity, dissolve mucus and stimulate the stomach. The following are the most important:

Sodium Bicarbonate	Magnesium Carbonate
Liquor Calcis (lime water)	Calcium Carbonate
Magnesium Oxide	Ammonia

Sodium Bicarbonate. This is indicated in disorders of the stomach to neutralize or counteract acids formed by fermentation of food or an excess of hydrochloric acid. It often produces good results in mild forms of indigestion when administered with a bitter and carminative before feeding or at the time of feeding. It is also useful as a gastric sedative in combination with one of the bismuth preparations in gastric catarrh.

Liquor Calcis. (Lime water) is very serviceable in prolonged vomiting due to excess acidity, also in chronic gastric catarrh with increased secretion of mucus. In this condition it may be used as a stomach wash (lavage) in small animals. It is frequently added to milk for calves and puppies to prevent the formation of large masses of casein in animals fed exclusively on milk. For this purpose it is used in the proportion of one part of lime water to four of milk. It is also serviceable in cases of irritable stomachs of dogs with hyperacidity, associated with vomiting.

Calcium Carbonate. (Common chalk). This is a bland antacid and feeble astringent. It is often employed in diarrheas for its protective, antacid and astringent effect, as follows:

Astringent for Cattle.

℞ Cretæ Præp. ..... ℥ iv
Tincturæ Opii ..... ℥ v
Tincturæ Catechu ..... ℥ v
Spts. Chloroformi ..... ℥ v
Aquæ q. s. .....ad.O. j
M. Ft. Mistura.
Sig. Shake and give 4 ounces three times daily in a pint of flour gruel.

Magnesium Oxidum. Calcined magnesia. There are two forms of this drug, the heavy and light magnesia. They are used chiefly as antacids and laxatives in young animals or as antidotes to arsenic poisoning either alone or in combination with iron in the official arsenic antidote, Ferri Hydratum cum Magnesii Oxido.

Magnesium Carbonate. Similar to above. May be combined with Magnesium sulphate with good effect as in

℞ Magnesii Carbonatis ..... gr. x
Magnesii Sulphatis ..... 3 j
Aquæ Menthæ Piperitæ ..... ℥ j
M. Ft. Sol.
Sig. Give at one dose as a laxative for a small dog.

3. DIGESTIVE FERMENTS

The digestive ferments used in medicine are:

Pepsin	Taka Diastase
Pancreatin	Papain
Rennin	Ingluvin
Diastase	Secretin
	Hormonal

PEPSINUM — PEPSIN

This is an enzyme usually obtained from the fresh mucous membrane of the hog's stomach. It is almost entirely soluble in 50 parts of water and more so in water acidulated with hydrochloric acid. It acts in a weakly acid medium to change the insoluble proteins of the food into soluble proteins. According to Sollmann, it is destroyed by 0.02 per cent. of NaOH and is inhibited by strong acids. The U. S. P. requires it to digest 3000 times its weight of coagulated egg protein at 125.6 °F. in 2½ hours in solutions of water containing one part of absolute hydrochloric acid in 3000 of water. It regularly contains some rennin, so will coagulate milk.

Fröhner advises the use of hydrochloric acid and pepsin in case either is indicated on account of the inability to ascertain which is needed in animals. He further states that they can be used in the treatment of all diseases of the stomach and disturbances of digestion in the course of febrile and general diseases with the exception of rarely occurring gastric ulcer in calves. In veterinary practice hydrochloric acid is more frequently used alone.

Doses.

Pepsinum. Horses. 5 j—ijss; 5—10. Dogs. grs. jss—xv; 0.1—1. Swine. grs. xxx—lx; 2—4.

PANCREATINUM — PANCREATIN

Pancreatin is usually obtained from the fresh pancreas of the hog or ox. It contains the specific ferments of the pancreas and represents its external secretion but there is no evidence that it represents its internal secretion and it has no power to check pancreatic diabetes. Its most notable actions are those of its enzymes, trypsin, amylopsin and steapsin. It acts best in an alkaline medium.

In regard to its protein and starch digesting power, the U. S. P. specifies that 1 grain of pancreatin with 5 grains of sodium bicarbonate must be able to peptonize completely 3 ounces of cow's milk at 100.4 °F., in 30 minutes. It further specifies that this amount of pancreatin (1 gr.) must be able to change 25 times its weight of

starch into substances soluble in water, i.e., into dextrose, maltose, etc.

FERMENTS NOT OF VERY GREAT USE IN MEDICINE

Rennin is not a digestant but a milk coagulating ferment obtained from the mucous membrance of the fourth stomach of calves. It is used extensively in cheese making.

Diastase is the starch digesting agent of barley malt, changing hydrolized or cooked starch into dextrine and maltose.

Taka-diastase is a ferment with diastatic properties obtained from a mould, *Aspergillus oryzæ,* which grows upon rice in Japan.

Papain is an enzyme obtained from the juice of the unripe fruit of *Carica papaya,* a South American papaw plant. It can digest albumen in an acid neutral or alkaline medium but works best in a slightly acid one. It has no indications.

Ingluvin is the dried lining membrane of the chicken's crop. Its digestive power is not very great. It has no therapeutic value in veterinary medicine but has been used empirically in vomiting of pregnancy in women.

Secretin is unstaple and is therefore of no use.

Hormonal is a preparation from the spleen of rabbits. It is said to contain the same peristaltic harmone as the gastric mucous membrane.

Since there is a tendency for the different ferments to destroy one another, mixtures of them, especially those acting in different media, are theoretically irrational.

OLEUM MORRHUÆ

Synonym. Cod Liver Oil

Cod liver oil is a fixed oil obtained from the fresh livers of various species of cod. Cod liver oil was formerly obtained by allowing the livers to decompose and collecting the oil set free. It is a pale yellow, thin, oily liquid, having a peculiar fishy, but not rancid odor, and a fishy taste. It is slightly soluble in alcohol, soluble in ether and chloroform.

Doses. Horses ℥ij—iv; 60—120. D. ʒj—ij; 4—8. Twice daily.

Cod liver oil must be regarded as a food and not a medicine. It is believed to be the most assimilable of fats. It increases weight and the condition of the patient generally. Large doses may cause nausea and diarrhea. Cod liver oil is especially useful in the treatment of malnutrition and during convalescence from febrile diseases. It has long been a popular drug in the treatment of tuberculosis of man and is valuable in the treatment of rickets of small animals.

Administration. There are several preparations of cod liver oil on the market that may be used. Many of these, however, are combined with hypophosphites which are very disagreeable and considered worthless by many pharmacologists.

The official emulsion is probably as good as any of the numerous commercial preparations. Cod liver oil is usually given two or three times daily.

Rachitis.

℞ Olei Phosphoratæ ..... ℥ j
Olei Moirhuæ q. s. .....ad. ℥ x
M. Ft. Sol.
Sig. Teaspoonful for small dogs or pigs. Tablespoonful for large ones, once daily.

4. CARMINATIVES

Carminatives are drugs that relieve pain by causing the expulsion of gas from the stomach or intestines. The usual cause of gas is the fermentation of food stuff. The excessive amount of gas distends the organ, and causes spasm of its muscular coats together with severe pain. The exact method of action of this class of drugs is not known, although numerous theories have been advanced. They probably act in the main by relaxing the spasm of the viscus especially at the orifices, allowing the gas to escape. To a certain extent they are irritants, causing an increase in the blood supply to the stomach and intestines and stimulating the movements of these organs. In addition they probably have some antiseptic or antiferment action, and serve as stomachics by increasing the activity of the glands. They are also of some use to allay spasm from other irritants than gas, as in colicky pains due to irritant foods or medicines. They are frequently prescribed with purgatives to prevent the griping from these agents. They should be avoided if inflammation has taken place.

With few exceptions, ether, chloroform, alcohol, they depend almost entirely upon a volatile oil, or a resin, for their action. The following are the most important:

Capsicum	Nutmeg	Fennel
Ginger	Cinnamon	Coriander
Turpentine	Anise	Asafœdita
Piper	Pimenta	Ether
Peppermint	Sassafras	Comp. Spts. Ether
Spearmint	Caraway	Chloroform
Cardamom	Cloves	Alcohol

Administration. Usually by mouth. Turpentine and asafœdita may be of considerable service in enemata.

CAPSICUM

Synonyms. Cayenne Pepper, Red Pepper

Parts Used. The fruit of *Capsicum frutescens,* a small shrub of tropical countries. Its active principle is Capsaicin.

Preparations and Doses:

Capsicum. H. and C. grs. xx—lx; 1.3—4. D. grs. j—viij; 0.06—0.5.

Fluidextractum Capsici. H. ♏ xx—lx; 1.3—4. D. ♏ j—viij; 0.06—0.5.

Oleoresina Capsici. H. ♏ x—xxx; 0.6—2. D. ♏ ¼—j; 0.016—0.06.

Tinctura Capsici. H. ℥ ij—iv; 8.—15. D. ♏ v—xxx; 0.3—2.

Action. Externally and locally capsicum is a sharp irritant producing burning, redness and even vesication. Its irritant action is much more prolonged and severe than mustard. Internally there is no effect except upon the gastro-intestinal canal. In therapeutic doses it produces a feeling of burning in the mouth and warmth to the stomach, stimulates peristalsis and aids in the expulsion of flatus. Large doses cause severe inflammation of the gastro-intestinal and genito-urinary tracts accompanied by vomiting and purging and scanty high colored urine.

Therapeutics.

1. *Externally.* As a counterirritant, it is not used so much as mustard because it is more powerful and the action is more prolonged.

2. *Internally.* As a carminative. It should always be well diluted as it is very irritant to the mouth.

Piper Nigra (Black Pepper). This is similar in action and uses to the above but is much weaker.

ZINGIBER

Synonym. Ginger

Parts Used. The rhizomes of *Zingiber officinale,* an herb growing in the tropics. It contains a volatile oil and an oleoresin.

Official Preparations and Doses.

Zingiber. H. ℥ij—℥j; 8.—30. Sh. & Sw. ℥ j—ij; 4.—8. D. gr. v—xv; 0.3—1.

Fluidextractum Zingiberis. H. ℥ij—℥j; 8.—30. D. ♏ v—xv; 0.3—1.

Tinctura Zingiberis. H. ℥j—ij; 30.—60. D. ♏ x—lx; 0.6—4.

Oleoresina Zingiberis. H. gr. x—xx; 0.6—1.3. D. gr. ss—j; 0.03—0.06.

Action and Uses. Ginger is principally used as a carminative and flavoring agent. It is often combined with bicarbonate of soda and bitters in atonic indigestion of horses and ruminants. It is also used simply as a carminative to expel flatus and is frequently administered with purgatives to prevent the griping of those agents, as is the case of aloes and magnesium sulphate.

Other Carminatives. The other carminatives belong to the volatile oil series and will be discussed later. Besides being carminative they are antiseptic and to some extent anesthetic. They include turpentine, oils of peppermint, spearmint, cloves, anise, sassafras, etc. Besides the above certain drugs are used for their flavoring power such as caraway, fennel, coriander, foenugreck. Ginger and capsicum are probably more used than any of the other carminatives with the possible exception of turpentine.

Turpentine. See p. 301. This agent is valuable in acute gastric tympany and flatulent colic to expel gas, arrest fermentation, and consequently relieve pain, also in tympanites of cattle. In either case it should be combined with an ammonia preparation and given with a full dose of linseed oil or it may be administered in a capsule. It is also an anthelmintic for round or tapeworms. For the former it should be combined with linseed oil and for the latter, with male fern (Hoare). It is contraindicated in congestion of the kidneys, nephritis, gastritis or enteritis.

Externally it is rubifacient, vesicant or pustulant according to strength and method of application. Used chiefly in liniments and blisters.

Tympany, horse or cow.

℞ Ol. Terebinthinæ ..... ℥ ij–iv
Spts. Ammoniæ Arom. ..... ℥ ij–iv
Ol. Menthæ Piperitæ ..... ℥ j
Ol. Lini q. s. .....ad. O. j
M. Ft. Haustus. Give at once.

Round Worms, adult dog.

℞ Ol. Chenopodii ..... ℥ j
Ol. Terebinthinæ ..... ℥ i
Chloroformi ..... ℥ ii
Ol. Ricini ..... ℥ xiv
M. Ft. Sol.
Sig. One-half to two drams in an equal amount of castor oil.
Hoare.

Mentha Piperita — peppermint: is a valuable carminative in colic and flatulence. *Externally,* it is a good antiseptic.

Mentha Viridis — spearmint: Similar to peppermint.

Cardamon. This is practically valueless except as an agreeable vehicle.

Ol. Cloves. This action is similar to oil of peppermint except that this oil has an additional action as a local anesthetic. It is used in human practice for this purpose in toothache. Cinnamon is similar to oil of cloves, but is slightly astringent.

Ol. Cajaputi. This is a serviceable, but little used, carminative. It is very useful combined with opium in diarrhea. *Externally,* it has been used with considerable value as a rubifacient in muscular rheumatism and as a parasiticide for ring worm.

See group of volatile oils for details of actions and uses of these drugs.

5. EMETICS

Vomiting consists of a reflex upward emptying of the stomach produced by a forceful contraction of its walls and compression of the abdominal muscles and diaphragm, accompanied by a simultaneous opening of the cardia and closure of the pylorus. If the pylorus is opened the effort results in a retch. Emesis is usually preceded by nausea and retching. The muscular walls of the stomach are important but not necessary since the stomach may be replaced with a bladder filled with water and emesis then takes place. The nerves involved are the vagi which conduct afferent impulses to the center and the phrenics, spinal nerves and vagi which conduct efferent impulses to the muscles involved.

Emetics are divided into local, topical or indirect; and general, central or direct. The direct emetics act upon the vomiting center directly and the indirect act on the center indirectly through an irritation of the sensory nerve endings in the stomach. The exact method of action is not easy to determine since drugs may be given intravenously and act on the center directly or they may be eliminated through the stomach and act on the center indirectly; or if given per os, they may irritate the stomach and cause emesis indirectly or they may be absorbed, carried to the brain and act directly upon the center.

Usually, however, if a drug produces emesis more promptly when given subcutaneosusly than by the mouth and causes emesis after the stomach has been replaced with a bladder filled with water, or after the arterial supply of the stomach has been cut off by ligature, it is assumed that the action is direct or central. Apomorphine acts purely centrally while copper sulphate, yellow sulphate of mercury, mustard, etc., are purely of peripheral or indirect action.

The number of emetics is very large. In fact anything that irritates the lining of the alimentary canal, especially the stomach, may act as a local emetic. Even water in sufficient quantity and es-

pecially if luke warm may serve this purpose and on this account it is frequently used as an adjuvant to other more powerful agents.

Although it is impossible to group emetics with exactness, the following classification may be made:

A. **Local Emetics.** Reflex. This group includes all the salts and especially the metallic ones: zinc and copper sulphate, tartar emetic, ammonium carbonate, alum, ipecac, senega, mustard.

B. **General or Direct:** Apomorphine.

Uses of Emetics.

1. To produce the nauseant stage.
2. To produce emesis.

1. (a) The nauseant stage is used principally in the treatment of inflammatory conditions of the respiratory tract, to increase the secretions or remove them, especially the mucous secretions from the air passages. They are useful when the secretions are scanty or thick and difficult to remove and are given in small doses repeated every two or three hours.

This is the only practical use of emetics in solipeds and other large animals, as horses do not vomit and cattle are not very susceptible to them. However, they are occasionally used in cattle practice to stimulate contractions of the rumen and even to cause emesis.

(b) In licking disease of cattle, wool eating in sheep, feather pulling in fowls and other cases of depraved appetites, emetics may be useful.

2. (a) To remove irritant food or poisons from the stomach.

(b) To expel foreign bodies, false membranes or excessive secretions from the upper air passages.

(c) To expel mucus and bile from the gall ducts in catarrhal jaundice by causing pressure on the liver. There is considerable doubt in regard to the efficacy of this treatment as the intestines are compressed and an overdistended liver might be ruptured.

Contraindications.

1. Advanced pregnancy: abortion may be produced.
2. Very weak animals.
3. Hernia: may aggravate condition or tendency toward hernia.
4. Ulcers and inflammation of stomach.
5. Retention of urine: may rupture bladder.
6. Caustic poisoning: may rupture the weakened walls.

Methods of Producing Emesis. 1. Tickling the fauces with a feather or running the finger down the throat is not usually effective when the stomach is normal but may be sufficient if it is irritable. A large draft of luke warm water may serve as an emetic in cases of irritable stomach but this is usually employed as an adjuvant to other emetics like mustard. (Mustard and water.)

2. A tablespoonful of mustard in a cup of warm water may act a little more vigorously than the preceding but is slow and unreliable but may be used in cases of emergency.

3. Alkalies. Any neutral salt in concentrated solution may act as an emetic by irritating the stomach. They are slow and uncertain of action, and with the exception of the ammonium salts which have a stimulating action, thus counteracting the depression which attends nausea, have no advantage. These ammonium salts should be used whenever further depression is dangerous. Ammonium carbonate is too slow for poisoning but is indicated in catarrhal conditions since it has additional value in dissolving the mucus. Ten to 20 grains may be given in solution frequently repeated until vomition takes place.

4. Metallic Salts. Most important and effective are: antimony and potassium tartrate, zinc and copper sulphate and alum.

Tartar emetic is quite slow, may be somewhat absorbed and is then very depressing. Copper and zinc sulphate are identical in action although the copper salt is to be preferred. They both irritate the stomach in some specific manner and reflexly start vomiting before the gastric wall has undergone any perceptible change. They are not absorbed so long as the mucosa of the stomach is intact and are consequently quite safe. They produce quick action and are accompanied by but little depression or nausea. They usually cause some irritation to the mucosa and on this account should be used to remove toxic material which is not irritating to the stomach. They should be strictly avoided when there is reason to believe the mucosa is injured since they would then be rapidly absorbed and cause poisoning. Their only advantages over apomorphine are: 1. that they are always available, 2. produce but little depression and nausea. In poisoning by phosphorus copper sulphate is especially indicated if any phosphorus remains in the stomach since metallic copper is precipitated, over the globules of phosphorus, quickly changing to the insoluble phosphide of copper. Used in 1 per cent. solution (about 5 grains) repeated at intervals.

5. Vegetable Irritants. Ipecac, veratrine, etc. These are slow and have side actions which limit their use more or less to the production of nausea. Ipecac is sometimes used as an emetic, 1 dram of the wine or syrup every 15 minutes or as a powder 15 grs. in luke warm water.

Veratrine, hypodermically, gr. ¼—⅓; (0.02.—0.03) in alcohol is the best emetic for swine according to Fröhner or veratrum may be administered per os or per rectum, dose for swine grs. vij—xxx; 0.5—2.

6. Apomorphine is the only alkaloid not a local irritant that is used as an emetic. It is indicated wherever a prompt action is desired and unless further depression is dangerous, it is administered

subcutaneously. If depression is dangerous ammonium carbonate should be given for slow, and copper sulphate for prompt action.

Summary. Apomorphine is the most powerful and reliable emetic. It may be given subcutaneously and causes but little nausea. It is useful in poisoning especially if there is difficulty in swallowing or when the stomach is not in condition for a mechanical or irritant material. It may not be effective in some cases of narcotic poisoning on account of depression of the vomiting center and may cause considerable depression in the aged or young. It is liable to deteriorate if exposed to the light or air.

Ipecac is safe and quite prompt. It is more depressant and not so prompt as the minerals. It is especially indicated in the young to unload the stomach or expel mucus from the air passages. The syrup or wine are best for puppies and kittens. We have killed several dogs with ipecac without producing emesis, consequently ipecac cannot be considered a reliable emetic for these animals.

Tartar Emetic. This has largely lost favor as an emetic on account of its prolonged period of depression, nausea, etc. Almost any other emetic is to be preferred. Used on robust animals only. Swine (grs. xv—xxx); 1.—2.; dogs, large (jss—jv 0.1—0.3 grs.). Wine for dogs in 3j—iv doses.

Zinc Sulphate. Chiefly in narcotic poisoning. Dose for dogs 10 to 30 grs.; 0.6—2.0 repeated in 15 to 30 minutes if necessary.

Copper Sulphate. More prompt and powerful than the previous. Dose for dogs 5 to 10 grains; 0.3—0.6.

Alum. Powdered alum is safe but uncertain of action. Dram doses may be given and repeated at intervals if necessary.

Mustard. Mustard flour or ground mustard is prompt and quite reliable. It is contraindicated in gastritis. Dose: Tablespoonful in hot or luke warm water, repeat in 10 to 15 minutes if necessary.

APOMORPHINÆ HYDROCHLORIDUM

This is an artificial alkaloid of morphine prepared by the abstraction of one molecule of water from the true alkaloid. It occurs as minute grayish white, shining crystals, without odor, and having a faintly bitter taste. One gram is soluble in 50 parts of water or alcohol and acquires a greenish tint on exposure to light and air. It should therefore be kept in amber vials well stoppered. The U. S. P. directs that it should be discarded if it imparts at once an emerald green color to 100 parts of distilled water. Some authors claim that the change in color is not detrimental to the drug.

Doses.

1. *As an emetic* for dogs: gr. $\frac{1}{30}$—$\frac{1}{6}$; 0.002—0.01; for cats: gr. $\frac{1}{60}$—$\frac{1}{30}$; 0.001—0.002.

According to Fröhner, cats require 10–25 times as much as dogs.

2. *Licking disease.* Cattle and Sheep, gr. jss—iij; 0.1—0.2. Young Cattle, gr. ¾—jss; 0.05—0.1. Calves, gr. ⅓—¾; 0.02—0.05.
3. *Expectorant.* Horses and Cattle, grs. ⅓—¾; 0.02—0.05. Dogs, grs. 1/60—1/20; 0.001—0.003.

Externally and locally there is no action.

Digestive System. Apomorphine is the most powerful and certain emetic we possess. Vomition begins in from five to twenty minutes after ingestion, depending on the size of the dose and method of administration, and is repeated at intervals of about fifteen minutes for three or four times. The emesis is preceded and attended by but slight nausea and moderate depression. Apomorphine is a typical direct or systemic emetic, its entire effect being exerted upon the vomiting center in the medulla.

Nervous System. Full doses stimulate the brain and may even cause delirium. This is followed by depression and paralysis. If it is administered in very large doses and especially to those animals which do not vomit, it shows its irritant effect upon other parts of the central nervous system. The animals show restlessness, circus movements, excitement, fear, and quickened respirations. Convulsions finally set in and death takes place through paralysis of the respiratory center.

Circulatory System. Small doses have no effect. During emesis the heart beats faster and stronger and arterial pressure is raised, due to stimulation of the accelerator nerves of the vasomotor system. Large doses paralyze the circulatory apparatus.

Respiratory System. Small doses do not affect the respirations but increase and fluidify the secretions from the respiratory tract probably by a nauseant action (expectorant).

Toxicology. Symptoms are violent vomiting, delirium, convulsions, and marked cardiac and respiratory depression. The treatment is similar to that for morphine poisoning.

Therapeutics.

1. Emetic for dogs and cats administered hypodermically.
2. As an expectorant for the sticky mucous discharges in bronchitis and catarrhal pneumonia. It should be given per os in small doses every two or three hours.
3. As a specific for licking disease of cattle and wool pulling or eating of sheep, administered subcutaneously.

℞ Apomorphinæ Hydrochloridi ..... gr. viij
Aquæ Destillatæ q. s. ..... ad. ℥ j
M. Ft. Sol.
Sig. 5 mils (1¼ ℥) once daily for a cow with licking disease.
Fröhner.

Permanent solution.

℞ Apomorphinæ Hydrochloridi ..... gr. iij
Solve in aqua dest. ..... ʒ v
Ad Acidi Hydrochloride ..... ♏ ij
M. Ft. Sol. This is a 1 per cent. solution for hypodermic use.

IPECACUANHA

Synonym. Ipecac

Parts Used. The dried roots and a small portion of the stem of *Cephælis Ipecacuanha* (Rio Ipecac) or *Cacuminata* (Cartagena Ipecac).

Constituents. Ipecac contains three alkaloids which contribute to its actions, one of which is of relatively little importance. These are *cephæline,* to which the emetic action is due for the greater part; *emetine,* which was so named when it was supposed to be the only active constituent present; and *psychotrine,* which is unimportant. The different alkaloids have not been studied in great detail, and we are not able to determine in every case to which we may attribute a given action of the crude drug.

Emetine is known to be less emetic than cephæline, but commercial specimens of emetine certainly cause emesis whether administered by the mouth or intravenously.

Preparations and Doses.

Fluidextractum Ipecacuanhæ, or powdered root. Expectorant. H. 3j—ij; 4.—8. D. gr. ⅛—¼; 0.01—0.05. Emetic. D. gr. v—xxx; 0.3—2.

Syrupus Ipecacuanhæ. Expectorant. D. ♏v—xxx; 0.3—2. Emetic. D. 3ss—iv; 2.—15.0.

Pulvis Opii et Ipecacuanhæ (Dover's Powder). See Opium p. 137. Expectorant. H. 3iv—viij; 15—30. D. gr. ij—x; 0.13—0.6.

**Tinctura Opii et Ipecacuanhæ.* Expectorant. Same as for above.

Action.

Externally and Locally. Ipecac is a powerful local irritant. The prolonged application or rubbing upon the skin causes much irritation, which may pass to vesication, pustulation or ulceration. It is also especially irritant to the mucous membrane of the respiratory tract.

Digestive System. Ipecac, in small doses, stimulates the stomach, increases the salivary and gastric secretions and serves as a bitter or stomachic.

Large doses are powerfully irritant and emetic, the emesis being produced largely by local action on the stomach, but there is reason

* Unofficial.

to believe that there is also some slight action on the vomiting center. The vomiting is preceded and attended by but little nausea but the nausea is quite lasting. Large doses usually increase the secretion of bile and intestinal mucus and therefore serve not only as emetics but also as chologogues and purgatives.

Respiratory System. The movements of respiration are not usually interfered with from ordinary doses. The bronchial mucous membrane is stimulated, increasing the secretion of mucus and thereby reflexly stimulating coughing. The increased secretion is probably due to the nauseant action. Since this action is persistent with ipecac, this drug is very useful as an expectorant when the secretions are thick and scanty.

Therapeutics.

1. As a mild emetic for swine, dogs and cats. It may be given as a powder or shake mixture. Swine and dogs. grs. xv—xlv; 1.—3. Cats. grs. iv—x; 0.25—0.75.

2. Antemetic in dogs and cats, in small doses where emesis is not dependent on some organic disease of the stomach.

3. As an expectorant in acute bronchitis before the secretions have started and in chronic bronchitis where they are scanty and viscid; also in catarrhal pneumonia and distemper of dogs, in small doses every few hours. Ipecac is most often administered as the syrup, wine or in combination with opium (Dover's Powders) for this purpose.

4. As a stimulant to the rumen of ruminants for overloaded rumen and for chronic catarrh of the stomach.

5. As a chologogue for icterus and liver disease.

6. As a diaphoretic, in form of Dover's Powders in the early stages of acute coryza, muscular rheumatism, etc. The diaphoresis is probably due to the nauseant action.

7. Antidysenteric. It is principally used for tropical dysentery in man, caused by amebæ, but is of no great service in veterinary practice for this purpose.

Expectorant, Dog. Acute stage of bronchitis.

℞ Vini Ipecacuanhæ ..... ʒ ijss
Potassii Citratis ..... ʒ iij
Tinct. Opii Camphoratæ.
Syrupus Acaciæ .....āā ʒ j
Aquæ q. s. .....ad. ℥ vj
M. Ft. Solutio.
Sig. Tablespoonful every 4 hours.

EMETINE HYDROCHLORIDE

Emetine is not only less nauseant than ipecac, but is also a powerful amebicide, to which the action of ipecac is entirely due in

amebic dysentery. It is also actively destructive to the endameba which is said to be the cause of pyorrhea dentalis and pyorrhea alveolaris in man. In these last mentioned cases the drug may be administered either by injecting it into the diseased parts or given subcutaneously in any convenient part of the body. This alkaloid also has some value as a hemostatic agent to check and prevent capillary hemorrhage and is used by some surgeons to prevent hemorrhage following operations upon the nose and throat. For this purpose it is injected hypodermically about one-half hour before operating. It is not definitely known just how emetine checks bleeding, but it is believed to act directly upon the capillaries since it does not lower blood pressure or increase the coagulability of the blood.

6. ANTEMETICS

These are agents used to check nausea and vomiting and are, of course, limited to canine and feline practice in veterinary medicine for this purpose. In the treatment of nausea and vomiting the animals should be kept as quiet as possible and allowed only small amounts of water or food at a time, since overloading the stomach with water or food will immediately bring on an attack of vomiting.

The antemetics may be grouped as:

1. **Antacids** to check the irritation due to hyperacidity: sodium bicarbonate, 10 to 20 grains, milk of magnesia, ½ to 2 drams, lime water.

2. **Protectives.** These form a protective coating on the mucous membrane of the stomach and mechanically prevent its irritation, in the same manner in which a dusting powder protects the skin or raw surfaces. The principal ones are the insoluble bismuth salts and cerium oxalate, dose of either 5 to 30 grains.

3. **Central Sedatives.** Chloral hydrate, morphine, etc., may be used in severe cases, but it must be remembered that morphine first causes emesis in dogs before it depresses the vomiting center, and one cannot depend upon its action in cats.

4. **Local Sedatives** which depress the sensory nerve endings in the stomach may be of advantage. These are cocaine, stovaine, dose of either $\frac{1}{12}$—¼ grain, and other members of the group of local anesthetics, tincture of belladonna, 5 to 15 minims, atropine $\frac{1}{200}$—$\frac{1}{100}$ grain, phenol 1—3 minims.

5. **Carminatives.** Chloroform water, ginger, peppermint, etc., are serviceable in human medicine, but as a rule the aromatics are objectionable to dogs and cats. Chloroform water may be of considerable service.

6. **Counterirritation** to the abdomen may be useful. Hot water bottle, ice bag, liniments, plaster.

7. PURGATIVES AND CATHARTICS

Cathartics or purgatives are agents which quicken or increase the evacuation from the bowel. They may produce this action (1) by direct irritation of the mucous membrane of the intestine; (2) by increasing the fluid of the feces, or (3) by stimulating the nerve endings in the intestinal walls with resulting peristalsis. In all cases peristalsis is increased. In the first place, the increased peristalsis is due to direct irritation of the mucous membrane; in the second place it is increased indirectly by distending the bowel with an increased amount of material, and in the last place by directly stimulating the nerve endings supplying the muscles of the intestine.

The vegetable purgatives, with the exception of the alkaloidal rapid purgatives, act through their irritant properties, and in some cases only after they are acted upon by the secretions of some of the glands. (Castor oil.) In moderate doses, the purgatives simply hasten the normal movements of the intestines and the stools are of the ordinary appearance and consistency. In increasingly larger doses they become of a softer consistency and even watery. Their action is usually accompanied by some colicky pain and the rapid movements of the intestinal contents are shown by the characteristic gurgling sounds. Large amounts of powerful purgatives cause all the symptoms of gastroenteritis. The stools in these cases at first contain the ordinary fecal matter, with more than the usual amount of fluid, but later consist almost entirely of blood-stained mucus, with little or no resemblance to fecal matter. This violent purgation is accompanied by other symptoms of gastroenteritis and may result in shock, collapse and finally death.

Neutral fats and saponified oils like butter, lard and olive oil pass practically through the stomach unchanged but are more or less completely saponified in the small intestines, and the resulting soaps may be sufficiently irritating to the intestinal mucous membrane to cause increased peristalsis and with the excess of the fat or oil act as a mild laxative.

The source of the increased fluid in the feces following purgatives has received a great deal of discussion. According to some authorities, purgatives simply accelerate the passage of the intestinal contents so that there is no time for absorption of the fluid and the feces are passed in the fluid condition in which they exist in the small intestine. Others hold that purgatives cause fluid to pass into the intestines either by increasing the normal secretions or by causing an inflammatory exudate from the vessels. Both have, to a certain extent, proved their theories by injecting purgatives into loops of the intestine isolated from the rest of the bowel. The contradictory results are probably due to different methods of investi-

gation, together with different amounts of the drugs used. It is now quite generally believed that with the small quantities usually employed in medicine, the irritation is probably only sufficient to accelerate peristalsis and the fluid condition of the feces is due to the fluid in the food and from the ordinary secretions from the digestive glands. In these cases the intestines are not actually inflamed but may be somewhat congested as in all glands in an abnormal state of activity.

But when excessive doses are given, there may be a true inflammation of the intestines accompanied by increased movement, congestion, exudation of fluid into the bowel and pain.

The colic is probably due not to the inflammation of the intestines but to the more vigorous muscular contractions of the bowel and the difficulty in forcing the hard fecal matter along. The interval between administration and purgation depends somewhat upon the dose, the individual drug, and the animal to which administered. Horses and cattle are rarely purged under 12—24 hours with the usual purgative measures, while dogs will usually purge in from 5 to 10 hours. The movements of the intestines caused by purgatives is accompanied by a marked leucocytosis, similar to that during digestion.

Effects Upon the Bile. It was formerly believed that a majority of the vegetable purgatives stimulated the liver and increased the secretion of bile. These were known as *cholagogues.* This action is now known not to exist except in a very few cases; the supposed cholagogue action is simply caused by the more rapid movements of the contents of the intestine, so that less time is given for absorption of the bile constituents, which are therefore found in greater quantity in the feces.

A cholagogue is defined as a substance which will increase the secretion of bile, and since the bile salts usually keep pace with the secretion, the amount of secretion can be generally accepted as an estimate of the cholagogue action.

The following conclusions have been drawn from experimentation:

Water, even in large amounts, does not alter the quantity of bile; and so the biliary secretion has been likened to the salivary and does not resemble that of the kidneys.

The bile itself or the bile salts are by far the most certain and powerful cholagogues we have. They produce a rapid increase, which lasts for several hours and the secretion corresponds to the amount given, the larger the dose the larger the secretion, the liquid and solids being increased proportionately.

Several other bodies have a mild or even moderate cholagogue effect, such as turpentine, sodium benzoate, sodium salicylate and podophyllum.

There are no sound therapeutic principles for the use of chologogues as such, but it has been found that the presence of bile in the intestine is necessary for the action of certain purgatives. Buckheim and Stadelmann found that in the absence of bile, the following drugs are quite inactive or at least very much less powerful than usual: podophyllum, jalap, scammony, rhubarb. It is believed that this is due to the solvent action of the bile, for Stadelmann found that if soaps were given with these agents their activity returned and that in other cases even a slight modification of their chemical nature was sufficient to restore their activity even in the absence of either bile or soap.

Similar results have been observed from other causes. For instance, some of the pure principles of the purgatives are less active than the crude drugs, because the impurities of the latter alter their solubility. According to Cushny, this alteration of the solubility may act in two ways: "If the principle is rendered too soluble, it may be absorbed in the stomach and upper part of the bowel, and therefore fail to produce purgation; on the other hand, it may be rendered so insoluble that it fails to come into intimate contact with the bowel wall, and therefore does not irritate it." According to Tappeiner, the effects of such colloid substances as the bile and gums is to delay the absorption of soluble substances as in the upper part of the bowel and at the same time keep the insoluble resins in suspension.

It is suggested that some of the purgatives have a more specific action upon the organism and increase peristalsis by action upon the nerves controlling it. Thus senna, aloin, frangulin, colocynthin and podophyllin cause purgation when administered either intravenously or subcutaneously, but it is believed that their action is due to their excretion into the bowel which will be inflamed as if given per os.

Finally there is some reason to believe that purgation may result from reflexes arising from the stomach or skin or local irritation in some part of the bowel; and these reflexes in some cases must pass through the central nervous system. Dixon says, "Any irritant injected subcutaneously behaves as a purgative."

General Indication for Purgatives.

1. Relieve constipation.
2. Remove irritants from the intestinal tract.
3. Promote absorption.
4. Remove waste products from the blood.
5. Relieve cerebral congestion.
6. Lower temperature in fever.
7. Deplete the gastroduodenal mucous membrane.
8. In the treatment of hemorrhoids or piles.

1. *Relieve constipation.* In acute simple constipation a cathartic or enema is always indicated. The vegetable laxatives are generally employed in chronic constipation if dietetic measures fail.

2. *Remove irritants from the intestinal tract.* Purgatives are indicated to remove irritants either in case of poisoning where the poison has escaped from the stomach or in early stages of acute diarrhea.

3. *Promote absorption.* In this case the hydrogogues, and especially the salines, are indicated in case of cardiac and renal dropsies. They remove fluid from the blood and promote the absorption of lymph from the tissues by depleting the blood. They do not often prove serviceable in serous effusions of an inflammatory nature as in pericarditis and pleurisy.

4. *Remove waste products from the blood,* as in uremia, puerperal eclampsia or azoturia to remove toxic material.

5. *Relieve cerebral congestion.* In this case the hydrogogue purgatives are indicated, since they tend to draw the blood to the bowels and to deplete the brain. They are also useful in cerebral hemorrhages, as they tend to prevent further extravasation of blood.

6. *Lower temperature in fever.* Both purgatives and diuretics lower temperature in fever in some unknown manner.

7. *Deplete the gastroduodenal mucosa,* where the congested and swollen mucosa obstructs the outflow of bile resulting in jaundice. In this condition the salines and especially the sodium salts are most efficient carthartics.

8. *Relieve hemorrhoids or piles.* In this case the milder cathartics such as sulphur, senna, compound licorice powder, etc., should be used.

Administration of Purgatives. Purgatives are most frequently given per os, although some are administered per rectum, subcutaneously and intravenously. The vegetable preparations are usually given as a pill or solution, although powders are occasionally prescribed. The oils are given in a drench and the salines in solution.

Classification. Cathartics have been grouped according to their chemistry, method of causing action, and according to their intensity of action and the character of feces obtained; but, since the intensity of action and character of action depend largely upon the dose, a classification so based must necessarily be imperfect. The following classes have been defined: laxatives, purgatives, drastics and hydrogogues.

Laxatives. These are the least irritating and least active of the cathartics. They produce stools quite normal in appearance and consistence. This group includes many foods, such as bran, molasses, and fruit. Most important drugs of this group are:

Manna	Cassia Fistula	Magnesia
Tamarind	Euonymus	Sulphur
Frangula	Butternut	Leptandra
Cascara Sagrada	Iris	Oxgall

Purgatives are more active than laxatives. They produce more abundant and somewhat liquid stools. The difference between these two groups is only in degree of action, as laxatives in large doses may be purgative and small doses of purgatives laxative. Usually placed in this group are:

Aloes	Castor Oil
Rhubarb	Calomel
Senna	Blue Mass

Drastics. These produce severe action and in overdoses act as irritants, causing symptoms of acute enteritis.

Croton Oil	Podophyllum
Colocynth	Jalap
Scammony	Bryonia

Hydragogues. These cause abundant, watery stools and are attended by but little irritation. The salines are the chief members of the group as,

Magnesium Sulphate	Potassium and Sodium Tartrate
Sodium Sulphate	Sodium Phosphate
Magnesium Citrate	Sodium Bitartrate

Aside from these a few of the drastics serve as hydragogues, in suitable doses, elaterium, jalap, bryonia.

For convenience of study, purgatives or cathartics will be grouped according to Bastedo with a few minor modifications.

A. **Irritants.**

(a) *Some very weak laxatives.*

	Sulphur
Liquid paraffin	Bile Salts

(b) *Fixed oils and their products (soap and glycerin).*

Olive oil	Castor oil
Castile soap	Linseed oil
Glycerin	

(c) *Anthracene derivatives or Simple purgatives.*

Aloes	Cascara Sagrada	Frangula
Senna	Rhubarb	
Phenolphthalein		

(d) *Cathartic mercurials.*

Calomel	Blue mass, etc.

(e) *Drastics.*

Elaterin	Podophyllin	Gamboge
Croton oil	Scammony	Colocynth
Jalap	Euonmymus	Jalap
Bryonia	Stillingia	Leplandra
Juglans		

(f) *Saline.*

B. **Subcutaneous.**

A. **Irritants.**

(a) *Some very weak laxatives.*

PETROLATUM LIQUIDUM — LIQUID PETROLATUM

Dose. D. 3j—iv; 4.—16. Cat. 3ss—j; 2.—4.

This is a mixture of liquid hydrocarbons, chiefly of the methane series, obtained by distilling off most of the lighter and more volatile portions of petroleum, and purifying the liquid residue. There are several oils of commerce which answer this description and which are marketed under trade names as petrolax, mineral oil, etc. Russian mineral oil is probably the nicest preparation. Most of these oils are practically odorless and tasteless and have been advanced as mild laxatives. Liquid petrolatum is not absorbed and the total amount administered may be recovered from the feces. The manner in which it produces action is not exactly known, but it is believed that it retards absorption on account of its oily nature, increases the bulk of the feces, and so stimulates peristalsis. At the same time it serves as a lubricant to the intestinal contents. Since it is non-irritating but, on the contrary, soothing to the gastrointestinal tract, it is proving of considerable value in small animal practice.

Sulphur is a mild laxative due to the decomposition of a small portion of the amount administered to the sulphides. Its use as a laxative is limited almost entirely to cases where a mild persistent action is desired, as in hemorrhoids. For complete description of sulphur see p. 439.

FEL BOVIS

Synonym. Oxgall — Fel Tauri

The fresh bile of Bos taurus.

Preparation. Extractum Fellis Bovis — Extract of ox gall.— Bile is of no use in medicine because it simply increases the secretion of bile and there is no condition in which this increased secretion is desired.

b. FIXED OILS AND THEIR PRODUCTS (SOAP AND GLYCERIN)

As stated previously neutral fats and saponified oils like butter and olive oil pass through the stomach unchanged, but are saponified more or less completely in the small intestine, and the resulting soaps may be sufficiently irritating to the intestinal mucous membrane to cause increased peristalsis, and, with an excess of the fat or oil, act as mild laxatives.

OLEUM OLIVAE — OLIVE OIL

Synonym. Sweet Oil

Source. This is a fixed oil expressed from the ripe fruit of *Olea europœa,* the common olive. It is rarely found in commerce in the pure form but usually adulterated with cottonseed oil. It is composed of olein 67 per cent., palmatin 28 per cent., linolein 5 per cent.

Dose. D. ℥ss—ij; 15.—60. Cat. 3j—℥j; 4.—15.

OLEUM AMYGDALÆ EXPRESSUM

Synonym. Expressed Oil of Almond

This is a fixed oil expressed from bitter or sweet almond. It contains, olein 76 per cent.; stearin and palmatin. Rarely used internally.

OLEUM GOSSYPII SEMINIS

Synonym. Cotton Seed Oil

This is a fixed oil expressed from the cotton seed, or different varieties of Gossypium, and subsequently purified. It contains olein and palmatin.

Dose. D. ℥ss—ij; 15.—60. Cat. 3j—℥j; 4.—15.

OLEUM LINI

Synonym. Linseed Oil

A fixed oil expressed from linseed. It contains the glycerides of linoleic acid, linolenic acid and insolinolenic acid. The official oil is commercially termed "raw oil," that is, the oil just as it comes from the press. For painting purposes the raw oil is cooked with litharge, thereby enhancing its "drying" properties. This oil is then termed "boiled oil" and should not be used in medicine since it is very toxic.

Dose. H. & C. O. j—ij; 500.—1000. Sh. & Sw. ℥vj—xij; 180.—360. D. 3ij—℥j; 8.—30.

Preparation. *Linimentum Calcis* (equal parts of lime water and linseed oil).

These oils are essentially nutritives and digestible fats, but in large amounts (1—2 tablespoonfuls for the dog, ½—1 pint for large animals) may be mildly laxative, being changed to soap and glycerin in the intestines. In larger amounts, they are only partly saponified, and more purgative, deriving some of their results from increasing the bulk of the intestinal contents.

Uses Internally. Olive oil and cottonseed oil are sometimes used as a laxative for small animals but not for large ones. Linseed oil is often used in large animal practice, particularly in horses, where it is not desired to produce severe purgation. It is also very serviceable in cattle practice although some authorities claim that the salines are to be preferred. Carron oil is a good preparation for administration to small and young animals and is often very serviceable in heaves of horses.

These oils may also be used as demulcents, to diminish excessive hydrochloric acid secretion in the stomach and to allay irritation of the rectum.

Externally they are demulcents, emollients, and protectives. Linimentum calcis is especially useful in burns of the first degree.

OLEUM RICINI

Synonym. Castor Oil

This is a fixed oil expressed from the seeds of *Ricinus communis,* a plant indigenous to southern Asia, and cultivated in temperate climates for ornamental and other purposes.

Doses. H. ʒxvj—xxxij; 500.—1000. Sh. & Sw. ʒij—viij; 60.—240. D. ʒss—ij; 15.—60.

Externally and Locally. Like other bland oils it is sedative and protectant when applied to the skin and mucosa.

Internally. The only important effect is upon the digestive tract, upon which it acts as a mild irritant, causing but little griping or flatulence and unloading the bowels thoroughly. Chemically castor oil is a combination of glycerin, fatty acids and ricinoleic acid. This combination passes unchanged through the stomach, but is broken down by the bile and pancreatic juice into glycerin and recinoleic acid. The latter combines with the sodium present and forms sodium ricinoleate, a soap which has marked irritating properties. This is also absorbed and excreted in various ways, appearing in the milk and imparting purgative properties to it. Castor oil requires from 4 to 5 hours to operate in the dog and much longer in the larger animals. It causes large soft stools and usually thor-

oughly empties the digestive tract. It is said to be unreliable as a purgative for horses.

The poisonous principle, *Ricin,* found in the seed coat of the bean, is an albuminous substance belonging to the globulin group and is usually termed a *tox globulin.* Ricin is one of the most toxic poisons known, but being soluble in water and not in oil, it is not present in expressed castor oil. The symptoms of poisoning from castor beans are violent abdominal pain, vomiting, purging, and collapse. Post mortem examinations show evidences of severe inflammation of the stomach and intestines with capillary thrombi in the various organs.

Therapeutics. 1. *Diarrhea.* It is one of the best agents we possess in diarrheas of young animals and should be given in the early stages of this condition. Fröhner says it is the best remedy for the diarrhea of dog distemper and other infectious intestinal diseases of dogs and should be preferred to opium.

2. Retained meconium in foals and calves. This condition is best relieved by two ounce doses of castor oil, followed by enemata of warm water or warm water and olive oil repeated, if necessary.

3. As a laxative in inflammatory conditions of the digestive tract.

4. To thoroughly unload the bowels of small animals for any reason.

Contraindications. It is not a good remedy in chronic constipation on account of its thorough emptying of the bowels and consequent constipation.

Administration. Castor oil is usually given alone. Moderate warming will thin the oil and lessen its nauseating effect. For horses and cattle it may be given with equal parts of warm water or two ounces of ether. For dogs and cats it is best given in an emulsion or with equal parts of olive oil, to which should be added 10—20 minims of spirits of nitrous ether, or it may be given in capsule.

For a Large Dog with Constipation.

℞ Olei Ricini ..... ℥ jss; 45.–50.
Acaciæ ..... ℥ ijss; 10.
Aqua q. s. .....ad. ℥ viij; 240.
M. Ft. Emulsum.
Sig. Give at one dose.

Fröhner.

Purgative for Dog.

℞ Olei Ricini ..... ℥ iij
Mucilaginis Acaciæ ..... ℥ jss
Syrupi ..... ℥ j
Aquæ Menthæ Piperitæ ..... ℥ ijss
M. Ft. Emulsion.
Sig. Two teaspoonfuls to a small dog, two ounces to a large one.

Purgative, Horse or Cow.

℞ Olei Ricini .....O. j –500.
Ætheris ..... ℥ ij 50.
M.
Sig. Give at one dose.

c. ANTHRACINE DERIVATIVES

ALOE

Synonym. Aloes

Aloe is the inspissated juice of the leaves of *Aloe vera, Aloe ferox, Aloe Perryi* or other species of aloe.

It will be noticed that according to the official definition there are three sources of aloes. The plant Aloes vera furnishes the Curacao aloes, Aloe Perryi yields Socotrine aloes while Aloe ferox produces what is commercially called Cape aloes. These plants somewhat resemble the Century plant. Aloe Barbadensis — Barbadoes Aloes — was formerly official and was the variety most often used in veterinary medicine.

Aloes occurs in yellowish brown or orange brown to blackish brown opaque masses, partially soluble in water, completely soluble in alcohol.

Preparations and Doses.

Aloes

	Stomachic		Laxative	
Cattle	ʒ j—ijss;	5. —10.	℥ jss—ijss;	45.—75.
Horses	ʒ ss—j;	2. — 5.	℥ ss—jss;	15.—45.
Sheep or Goats	ʒ ss—j;	2. — 5.	ʒ ijss—vj;	10.—25.
Swine	grs. xv—xxx	1. — 2.	ʒ j—ijss;	5.—10.
Dogs	gr. jss—vij;	0.1 — 0.5	ʒ ss—j;	2.— 5.
Cats	gr. ¾—iij;	0.05— 0.2	grs. iij—xv;	0.2— 1.

Laxative Doses for Foals are:

1 week old	gr. viij—xv;	0.5— 1.0
4 weeks old	ʒ ss—ʒj;	2. — 4.
3 months old	ʒ j—ijss;	4. —10.
6 months old	ʒ ijss—iv;	10. —15.
1 year old	ʒ iv—v;	15. —20.
2 years old	ʒ v—vj;	20. —25.
3 years old	ʒ vj—viij;	25. —30.
4 years old	ʒ vj—℥ jss;	25. —45.

Fröhner.

Tinctura Aloes — Tincture of Aloes, 10 per cent.
* *Tinctura Aloes et Myrrhæ* — Tincture of aloes and Myrrh.

* Unofficial.

10 per cent. of each. Aloes also enter into the composition of numerous pills.

Active Constituent. The active constituent is a neutral principle *aloinum* (aloin). This varies more or less in chemical composition and physical properties according to the source from which obtained. It is chiefly prepared from Curacao aloes. It occurs as a light to dark yellow powder, of slight odor but intensely bitter taste. Soluble in about 65 parts of water and 10.75 of alcohol.

Dose ¼—½ that of aloes.

Action. There is no profound action beyond the digestive tract. It is slightly stomachic in small doses increasing the secretions from the entire tract. It is also thought to increase the secretion of bile. Its purgative action is largely exerted on the large intestine. It stimulates the muscular coats of this organ (increased peristalsis) as well as increasing its secretions.

Aloes requires from 12 to 36 hours to produce purgation, but usually purgation will not take place in less than 18 hours unless the horse has been prepared by a few messes of bran.

Purgation may last from 3 to 24 hours. It is not safe to repeat an aloes purge inside of 48 hours as superpurgation may result. If at the end of 16 to 18 hours purgation has not started, the horse may be gently walked, and returned to the stall when signs of purgation show. During active catharsis horses will be off feed, colicky, and suffer from griping caused by the violent peristalsis. It is on this account that a carminative is usually added to aloes. These symptoms should be kept in mind so that one will not be misled by the workings of an aloes purge.

Large doses congest the pelvic viscera, irritate the rectum and may cause abortion.

Ruminants are not so susceptible to aloes as horses and this drug is therefore not certain in action but if combined with other purgatives it is believed to assist their action. Dogs and cats require much more aloes for purgative action than man. According to Fröhner, dogs require 5 to 10 times as much.

Therapeutics. 1. Wherever a good brisk cathartic is desired: colic, hidebound, overloaded stomach or bowels, to expel worms after a vermicide, to promote the excretion of waste products from the bowels and blood: in fact, in those conditions demanding strong purgation.

2. As a tonic where a bitter tonic is desired. Here it is frequently difficult of administration as the animals will often refuse to take it if mixed with the feed.

3. As a stimulant to wounds. Comp. tincture of aloes and myrrh.

Contraindications. In inflammations of the digestive tract,

piles, high fever, weak and debilitated animals, cystitis, inflammation of the pelvic organs, pregnancy, and in milking animals the milk will have a bitter taste. Animals which are suckling the young may excrete enough aloes through the milk to purge the young. In influenza and catarrhal and respiratory diseases it should be given in very small doses, if at all, on account of the liability to cause superpurgation.

Administration. Aloes is usually given per os in the form of a bolus or pill on account of its disagreeable taste. As a tonic it may be given in small doses upon the food if the animal will eat it. Some of its liquid preparations are given in solution. Occasionally aloin is given in solution. Where it is desired to make pills (boli), aloes is melted over a water bath, at a temperature not exceeding 120° F., the other ingredients added and then a small amount of glycerin is added to the whole so that the mass will not dry so rapidly. In cases where it is desired to simply purge an animal he may be prepared for the purge by feeding on bran mashes for a day or two before administering the aloes. A carminative is often added to aloes to lessen the griping. Atropine or belladonna is also added occasionally for the same purpose. Aloes will also cause purgation when given by enema provided it is administered with bile or some solvent like glycerin.

There are certain precautions which should be taken when administering a purgative dose of aloes to a horse.

He may be gently walked 12 hours after the dose if purgation does not take place, but upon its appearance should be kept in the stable. His water should be warmed. His food should be limited to hay and bran, if he will take any nourishment at all, he should not be allowed any green food and should not be worked until purgation ceases.

Purge for Horse.

℞ Aloes ..... ℥ vj–viij
Hydrargyri Chloridi Mitis .....grs. xxx–lx
Nucis Vomicæ ..... ℥ j
Zingiberis ..... ℥ ij
M. Ft. Bolus.
Sig. One dose.

Wound Dressing.

℞ Tincturæ Aloes.
Tincturæ Myrrh āā. q. s.
M. Ft. Sol.
Sig. Apply to wound.

RHEUM

Synonym. Rhubarb

Parts Used. The rhizomes and roots of *Rheum officinale* and other species of rheum, a perennial herb, resembling garden rhu-

barb but of larger growth, and native to Asia. There are several official preparations but the drug is not much used in veterinary medicine.

Preparations and Doses.

Rhubarb.

	Stomachic		Astringent		Laxative	
Horses	℥ ijss–vj;	10.–25.	℥ vj; ℧ jss;	25.–50.	Not Used	
Foals, Calves, Sheep and Swine	℥ ss–j;	2.– 5.	℥ j–ijss;	5.–10.	℧ jss–iij	50.–100.
Dogs	grs. vij–xv;	0.5.– 1.	grs. xv–xxx;	1.– 2.	℥ j–iv	5.– 15.
Cats	gr. jss–viij;	0.1.–0.5.	gr. vij–xv;	0.5.– 1.	grs. jss–℥ j;	1.– 5.

Fluidextract 100 per cent.

Tinctura Rhei 20 per cent.— contains cardamon also.

Tinctura Rhei Aromatica — 20 per cent. rhubarb, plus cinnamon, cloves, nutmeg.

Pulvis Rhei Compositus, Compound Powder of Rhubarb. Rhubarb 25, magnesium oxide 65, ginger 10.

Extractum Rhei, twice the strength of the crude drug.

Syrupus Rhei 10 per cent. *Doses.* ℥ j—iij; 4.—12.

Syrupus Rhei Aromaticus 3 per cent. *Doses.* Same as for syrup.

* *Mistura Rhei et Sodii.* Sodium bicarbonate 35, fluidextract of rhubarb 15, fluidextract of ipecac 3, glycerin 350, spirit of peppermint 35, water to make 1000.

Action. Rhubarb contains chrysophanic acid, emodin and rheotannic acid. The chrysophanic acid is quite irritant, but it is absorbed before reaching the colon, so does not participate in the typical rhubarb action. Rhubarb is described as stomachic and astringent in small doses and laxative in large ones, but the astringent action tends to assert itself even after the laxative action has been induced. The aromatics enhance its astringent effect and explain why the aromatic syrup is astringent and syrup of rhubarb is laxative. It is said that it does not produce purgation in horses and cattle even in large amounts.

Therapeutics. The uses of rhubarb closely follow its action.

1. In small doses it serves as a bitter stomachic.

2. In medium doses it is an astringent and is quite serviceable in diarrheas of young animals. For this action it should be combined with aromatics and sodium bicarbonate.

3. As a laxative in young animals which are suffering from constipation, rhubarb may be very serviceable. It is also very serviceable in the early stages of diarrhea in these animals to sweep out the irritant material from the intestines, and then to check intestinal movements. Combined with calomel it is a purgative for

* Unofficial.

the dog. One or two drops of the tincture in the drinking water will serve as a laxative for small birds. It is not a suitable remedy for chronic constipation on account of its tendency toward astringent action.

Diarrhea — Puppy.

℞ Magnesii Oxidi .....grs. xl
Syrupi Rhei Aromatici ..... ʒ vj
Aquæ Menthæ Piperitæ q. s.....ad. ℥ j
M. Ft. Sol.
Sig. One-half to one teaspoonful repeated twice at intervals of one hour.

Indigestion, Dog, from overeating.

℞ Nucis Vomicæ ..... gr. xij
Rhei .....gr. xxiv
Sodii Bicarbonatis ..... ʒ j
M. Ft. Chart. No. XII.
Sig. One before feeding.

CASCARA SAGRADA

Synonyms. Rhamnus Purshiana, California Buckthorn.

Parts Used. The dried bark of *Rhamnus Purshiana* collected at least one year before being used.

Preparations and Doses.

Fluidextractum Cascaræ Sagradæ. D. ♏ xv—xxx; 0.3—2.
Fluidextractum Cascaræ Sagradæ Aromaticum. D. ♏ xv—xxx; 0.3—2.
Extractum Cascaræ Sagradæ. D. grs. iij—viij; 0.12—.5.

Action. This is a very efficient laxative for dogs and other small animals. Besides its purgative properties it contains a bitter principle which gives it some stomachic properties. Its action is seldom attended with any irritation or unpleasant symptoms, requiring from 6 to 10 hours to produce effect.

Therapeutics. This drug is chiefly used to overcome chronic constipation due to torpor of the bowels. It is of slow action and is better fitted to regulate the bowels than to evacuate them. When used in chronic constipation the dose should be gradually diminished until a natural passage is obtained. Its chief advantage is that animals do not develop a tolerance for it, when it is used over long periods or frequently. It can be given as the extract in pills or as the fluidextract or aromatic fluidextract without dilution.

FRANGULA

Synonym. Buckthorn

The dried bark of *Rhamnus Frangula,* collected at least one year before being used.

Preparations.

Fluidextractum Frangulæ.

D. ℥ ss—j.; 2.—4.

The action and uses of Frangula are similar to those of the previous drug but it has been largely replaced by it.

SENNA

Senna is the dried leaflets of *Cassia Acutifolia* (Alexandria Senna) or of *Cassia angustifolia* (India Senna).

Preparations and Doses.

Senna. Horses and Cattle ℥ iv—v; 120.—150. Sheep and Swine. ℥ j—ij; 30.—60. Dog and Cat. ℥ j—iv; 4.—16.

Fluidextractum Sennæ 100 per cent. Same as Senna.

Infusum Sennæ Compositum, 6 per cent. with manna, magnesium sulphate, fennel and water. D. ℥ j—iv; 4.—15.

* *Confectio Sennæ* 10 per cent. with cassia fistula, tamarinds, prune, fig, sugar, coriander and water.

Syrupus Sennæ — 25 per cent. Dogs. ℥ j—iv; 4.—15.

Pulvis Glycyrrhizæ Compositus — Compound licorice powder (senna 180, licorice 236, washed sulphur 80, oil of fennel 4, sugar 500).

D. ℥ ss—ij; 2.—8.

Action and Uses. Senna resembles the preceding drugs in action and uses but is not often used in veterinary practice.

LAXATIVE PHTHLEINS

Phenolphthaleinum — *Purgen.* This is an artificial anthracene derivative, prepared by the interaction of phenol and phthalic acid. It is a white crystalline powder, slightly soluble in water, 600 parts, and freely so in alcohol, 10 parts. It is used for the small animals only in doses of from $\frac{1}{10}$ to 4 or 5 grains. It is an agreeable and fairly reliable purgative, producing large watery stools, and appears to have no other action. Solutions in oil injected subcutaneously cause purgation without local irritation. This is the drug upon which most of the candy cathartics depend for their action. It may be given in pill and is sometimes combined with calomel when that agent is to be given in small divided doses.

d. THE MERCURIALS

This group comprises the insoluble purgative mercurials, calomel (mild mercurous chloride), mass of mercury (blue mass), and mer-

* Unofficial.

cury with chalk (gray powder). These agents have little if any action on the stomach unless their passage through it is delayed. They are believed to produce their purgative action by mildly irritating the intestines with some possible increase in the intestinal secretions, thereby stimulating peristalsis both directly and indirectly.

The evacuations from the mercurials are large and loose and may be charged with undecomposed bile. They are not usually accompanied by much griping but large doses may cause considerable colic and watery feces, and nausea in some animals. For a long time it was thought that calomel was a distinct chologogue, but later researches show that it serves this purpose only indirectly by moving the aliment away from the bile duct and thus facilitating the discharge of bile into the intestine.

There is considerable uncertainty concerning the antiseptic action of calomel in the intestines. It is generally believed that it does not destroy the bacteria or even greatly inhibit their growth in the intestines, but does remove great numbers through purgation.

Only a small portion of mercurials is absorbed if evacuation is produced quickly, but if there is interference with the passage of the intestinal contents after a large dose of them, diuresis is produced. This interference is occasionally secured by administering morphine or opium with small doses of calomel, but if it occurs after large doses toxic symptoms referable to the irritant action of mercury on the kidneys and other symptoms of mercurialism may result. Consequently some means should be taken to induce purgation if the mercurials fail to act unless small doses are given for their diuretic action.

Calomel acts as a laxative or purgative according to the method of administration and dosage used. It differs from most other purgatives in that its cathartic effect does not increase in a ratio with the dose. Fractional doses repeated at half hour intervals, until 1 or 2 grs. (dog) have been taken will produce more purgation than 10 grs. taken at a single dose.

Therapeutics. Calomel is indicated as a purgative in biliousness characterized by coated tongue, foul breath, etc. It is also especially good to unload the bowels early in an infectious disease, since it unloads the bowels thoroughly and carries out many bacteria.

Calomel is often added to the ordinary aloes pill for horses as it is believed to assist the action of aloes.

Fröhner states that it may be abortifacient in canine distemper but most authorities do not agree on this use.

The other preparations of mercury have similar actions and uses. In veterinary practice, probably calomel is more used in the treatment of the small animals than the large. Pills of $\frac{1}{10}$ grain each of calomel have proved very serviceable in digestive derangement of cats (constipation).

Administration. Calomel is usually given in ball or pill and it is best always to follow with a purgative, particularly the salines. Sodium bicarbonate is often added to calomel under the impression that it is necessary to combine an alkali with a mercurous salt to prevent its conversion into a mercuric salt by the gastric juice; but the amount so combined is not adequate to neutralize more than a small amount of the gastric juice. Furthermore, no such change takes place when calomel is subjected to the action of the gastric juice.

Doses. Calomel (Hydrargyri Chloridi Mite). H. and C. 3jss—ij; 6.—8. Dog. gr. ss—jss; 0.03—0.1. Cat. gr. 1/10—1/5; 0.006—0.012.

For complete materia medica see Mercury, p. 426.

e. DRASTICS — ANHYDRIDS

These bodies are mostly of uncertain composition, some glucosides, as colocynth and jalap, and other bitter principles, neither acid, glucosidal, nor alkaloidal in nature, as elaterium and podophyllum. These drugs are much more irritant than the anthracine group studied previously and large doses readily set up acute gastroenteritis with violent peristalsis and exudation of muco-purulent material, which may be blood-stained in some cases.

After very large doses the feces are very fluid, and griping is severe, while excessive doses may cause bloody stools, collapse and even death.

General Uses of the Drastics. With the exception of podophyllum and its resin, all the members are used to secure prompt evacuation of the bowels and are capable of producing profuse watery feces. Their action is very similar, differing only in minor details, so that it is of little importance which is chosen for a given case. In general, they are indicated only where a prompt thorough emptying of the bowels is desired. They are contraindicated in inflammatory conditions of the digestive tract and large doses are contradindicated in pregnancy.

OLEUM TIGLII

Synonym. Croton Oil

This is a fixed oil expressed from the seeds of *Croton Tiglium.*

Doses. H. ♏ x—xxx; 0.6—2. C. ♏ xxx—lx; 2.—4. D. ♏ 1/4—j; 0.015—0.065.

It should always be administered in some bland oil, as it is very irritating.

Action. Croton oil contains a resin-like substance which is a

powerful irritant when applied to the skin, exciting inflammation, vesication and even pustulation.

Internally. Croton oil contains some free crotonoleic acid, which is irritant to the body tissues. It is decomposed in the small intestines to *Croton oleates* which are much more actively irritating than the ricinoleates. It is therefore a drastic purgative, producing copious amounts of feces. Its action is attended with a great deal of griping and oftentimes nausea. Large or excessive doses cause gastroenteritis, accompanied by prostration and collapse.

Therapeutics. Its internal use is almost entirely confined to cattle practice, where it is used as a strong purgative. It is not usually employed except as an extreme measure.

Externally as a strong counterirritant, for blister, etc. It is often used upon cattle but rarely on horses, as its action is very severe.

Administration. It should be given by the mouth, mixed with some bland oil or as an emulsion.

Impaction of Omasum, Cow.

℞ Olei Lini ..... O. ij
Olei Tiglii ..... ♏ xxx
M. Ft. Sol.
Sig. Give at one dose.

Blister.

℞ Olei Tiglii ..... ʒ iv
Olei Lini ..... ʒ xiij
Olei Terebinthinæ ..... ʒ ij
Camphoræ ..... ʒ j
Petrolati ..... ʒ ij
Acidi Sulphurici ..... ʒ ij
M. Ft. Sol.
Sig. Apply as directed with but little friction.

ELATERINUM — ELATERIN

This is a neutral principle obtained from elaterium, a substance deposited by the juice of the fruit of *Ecballium Elaterium,* or squirting cucumber, a vine indigenous to the Mediterranean shores.

Doses.

Elaterinum. H. gr. ss—ij; 0.03—0.13. D. gr. ½₀—⅒; 0.003—0.006.

Trituratio Elaterini — Trituration of Elaterin (Elaterin 10, Milk Sugar 90). Dog. gr. ½—1.; 0.032—0.065.

Elaterin is exceedingly irritant to all tissues. Administered by the mouth it is probably the most powerful hydrogogue purgative known. It produces large, watery stools very promptly. Its action is said to be stronger than jalap and less active than gamboge or

colocynth, and is attended with much griping, pain and prostration. In overdoses it is a violent poison.

Therapeutics. Elaterin is not used to any extent in veterinary medicine but would be indicated, if at all, in those cases where we desire profuse, watery discharges, such as congestion of the brain, ascites, uremia, poisoning, etc. It is contraindicated in inflammations of the digestive tract and pregnancy.

CAMBOGIA

Synonyms. Gamboge, Pipe Gamboge

This is a gum resin obtained from *Garcinia Hanburii,* a medium sized laurel-like tree of Siam. It occurs as a yellow powder.

Doses. Cattle. 3ij—℥j; 8.—30.

The action and uses of gambogia are similar to those of the other hydrogogues, but it is not of much use. It is too irritant for dogs and horses and practically never used alone, but usually associated with other cathartics, as epsom salts. One ounce of gamboge, with one-half pound each of epsom salts and common salt in one quart of water make an efficient purgative for cattle.

JALAPA

Synonym. Jalap.

Jalap is the dried tuberous root of *Exogonium Purga,* a plant grown on the eastern slopes of the Mexican Andes. It contains two glucosides, convolvulin and jalapin.

Doses and Preparations.

Jalapa. D. grs. x—lx; 0.6—4. Pigs. 3j—iv; 4.—16.
Oleoresina Jalapæ. D. grs. j—x; 0.065—0.6. Pigs. grs. vij—xxx; 0.5—2.

The action and uses of jalap are similar to the other hydrogogues, so they will not be discussed again. It is but little used in veterinary medicine.

* BRYONIA

Synonym. Bryony

The parts used are the roots of *Bryonia alba and dioica,* climbing plants of Central and Southern Europe. It is a drastic purgative but its use has been practically discontinued.

PODOPHYLLUM

Synonyms. May Apple, Mandrake (vegetable calomel of Germans)

The parts used are the rhizomes and roots of *Podophyllum peltatum,* an herb growing in moist shady places of northern United

* Unofficial.

States and Canada. Its active principles are two glucosides, podophyllotoxin and picropodophyllin. These are not present as such in the fresh root but develop on drying. The root is best after two years' drying. Podophyllin is the trade name for the resin.

Preparations and Doses.

Podophyllum. H. 3j—ijss; 5—10. D. gr. jss—iv; 0.1—0.25.

Fluidextractum Podophylli. Same as powdered root.

Resina Podophylli (Podophyllin). D. gr. $\frac{1}{12}$—j; 0.1—0.25.

Podophyllum or its resin is a constituent of several pills.

Podophyllum is an energetic, slow acting, irritant cathartic. Its action is attended with considerable pain and griping. It was formerly believed and is still believed by some authorities to directly stimulate the secretion of bile, but this is doubtful.

Therapeutics. It is often preferred to the other hydragogues and is especially useful in habitual constipation associated with torpidity of the liver. If combined with other purgatives, only those of slow action should be chosen, such as aloes, calomel, etc. Antispasmodics, such as belladonna, should be added to prevent griping. It is uncertain in action upon horses and cattle.

℞ Aloini ..... gr. ¼
Cascarini ..... gr. ¼
Podophyllini ..... gr. ⅛
Ext. Belladonnæ ..... gr. ¼
Laxative pill for dog.

COLOCYNTHIS

Synonyms. Colocynth, Bitter Apple, Colocynth Pulp

Parts used are the seeds of *Citrullus Colocynthis* deprived of their rind. Indigenous to arid parts of Asia, Africa, and Southern Europe.

Extractum Colocynthidis. Swine. gr. ss—ij; 0.3; 0.13. D. gr. ⅛—¼; 0.01—0.03.

Extractum Colocynthidis Compositum. Swine. gr. iv—xv; 0.25—1. D. gr. j—viij; 0.065—0.5.

SCAMMONIAE RADIX

Synonym. Scammony Root

This is the dried root of *Convolvulus Scammonia,* a perennial herb growing in Western Asia. Its active principle is scammonin, a resin.

The above two drugs are drastic purgatives. Colocynth is said

to be of uncertain action in the horse and dog. Scammonia is one of the oldest drastics. Its use dates back to the time of Hippocrates but has been about abandoned.

Other drugs of this group are: Leptandra (Culver's Root), Iris (Blue Flag), Stellingia (Queen's Root) and Juglans (Butternut). These drugs are rarely used in veterinary medicine.

f. SALINES

The most prominent members of this group are sodium sulphate, magnesium sulphate, potassium sulphate, sodium and potassium tartrate, potassium bitartrate and magnesium oxide.

The salines differ from the vegetable purgatives in being but feeble irritants to the intestines. It was formerly believed that the salines stimulated more or less secretion from the intestinal canal, while their slow diffusibility impeded the absorption of the secreted fluid and it was on this account that they were recommended to be given in concentrated solutions. It has been shown that this theory was wrong, because the purgative action is not proportional to their endosmotic equivalent.

All saline substances are not absorbed at the same rate. Some are rapidly taken up from the stomach and intestines, and others so slowly that they reach the large intestines before any appreciable absorption has taken place. The kation magnesium is absorbed the most slowly, calcium, a little more readily and those of potassium, sodium and lithium, about equally but more rapidly than calcium.

The chlorides are the anions absorbed most rapidly, then come the bromides, iodides, nitrates and lastly the sulphates, the last-named being almost entirely excreted by the rectum. The cathartic action of an ion depends on the time required for its absorption, the slower the absorption, other things being equal, the greater the purgative effect.

On account of their being nonabsorbable, these salts exert their osmotic properties in the following ways: If a concentrated solution of a slightly diffusible (absorbable) salt is taken into the stomach, it becomes diluted with the liquid present, or if the stomach was empty it draws fluid from the cells of the stomach, causing irritation, with nausea and at times even vomition.

The rate of the dilution in the stomach, in the absence of fluid present, depends somewhat upon the amount of fluid in the blood and tissues. If they contain large quantities of fluid, the dilution will be fairly rapid and when the solution has become fairly diluted it will pass on into the small intestines. However, if the blood and secretions do not contain fair amounts of water, the dilution is slow and vomiting may take place, but if water is freely supplied, the nausea is not so marked and may not be seen.

Upon reaching the intestines the solution retains its water until

its concentration approximates that of the blood. The distention of the intestines by the fluid stimulates peristalsis, both in the large and small intestines.

The cathartic salts are not absolutely non-absorbable, and so if peristalsis is prevented by some means, their solutions may be almost completely absorbed into the blood and cause diuresis if the absorption has been sufficiently rapid, because the renal epithelium is permeable to these salts. On the other hand, those salines which are rapidly absorbed act as diuretics, since they withdraw fluid from the tissues into the blood, and consequently increase blood pressure in the kidneys. Furthermore, they are readily diffusible to the epithelium of the kidneys.

There is considerable controversy concerning just how the purgative action of salines takes place, but it is believed to be due, almost if not entirely, to their physical relation to the tissues (osmotic properties).

In the first place, they increase the fluid in the intestinal canal. For instance, if an isotonic solution of epsom salts is injected into a loop of intestine, very little secretion or absorption occurs, so that after a few hours' time the same amount of salt and liquid may be obtained. If stronger, hypertonic solutions are used, the fluid in the loop will be increased on account of osmotic action. The presence of these non-absorbable salts in the intestines prevents the normal absorption of fluid, and hence a much larger amount will reach the large intestine and the contents of the bowel will necessarily be more fluid. The increased amount of fluid causes distention of the bowel and this will stimulate peristalsis. Isotonic and hypotonic solutions of the cathartic salts will prevent absorption but only concentrated hypertonic solutions draw fluid from the tissues and blood and may fail to cause purgation if the blood tissues contain very little fluid, as has been shown in experimental work on animals which have been deprived of water for a few days previously; but, on the contrary, where large quantities of fluid are present in the system, as in edema, the salines, administered in concentration (hypertonic solutions), produce purgation readily by drawing fluid indirectly through the blood into the bowel. It is on account of the fact that hypertonic (concentrated) solutions must get their water from the tissues, that they require much longer to produce their action than weak solutions, and consequently, unless it is desired to remove a large amount of fluid from the body, as in edema, they should be given well diluted and the animal allowed plenty of water.

The salines prove very serviceable for ruminants and small animals, but are not especially dependable in equine medicine.

SUMMARY OF ACTION OF SALINES

1. They irritate the stomach and are liable to cause nausea and vomiting, but this can be largely overcome by administering them in dilute solution and supplying plenty of water.

2. Their cathartic action is largely due to the increased bulk and fluidity of the intestinal contents, which are chiefly due to the inhibited absorption.

3. If elimination by the intestinal canal is prevented, they do not cause inflammation of the bowels and are absorbed.

4. If absorbed, they are eliminated by the kidneys and act as diuretics.

5. The feces following salines are fluid but do not contain inflammatory products.

6. In moderately hypertonic solutions, they tend to remove fluid from the body.

MATERIA MEDICA AND USES OF DIFFERENT SALINES

MAGNESII SULPHAS — MAGNESIUM SULPHATE

Synonym. Epsom Salts

Description. Small, colorless, prismatic needles or rhombic prisms without odor and having a cooling, saline and bitter taste. Soluble in 0.85 part of water at 25° C. (77° F.) and in 0.13 part of boiling water; insoluble in alcohol.

Doses. Horse. ℔. ss—ij; 250—500. Cattle. ℔. j—ij; 500—1000. Sheep and Goats. ʒij—iv; 60.—120. Swine. ʒij—iv; 60.—120. Dogs. ʒijss—ʒij; 10—60. Cats and Fowls. ʒss—j; 2.—4.

Therapeutics. 1. As a purgative especially for cattle or other ruminant. It should be administered in solution in water, together with some carminative. Sodium chloride is sometimes prescribed with it and is said to increase the catharsis.

2. Laxative and mild purgative for the horse. In this animal active catharsis does not usually take place, but if administered in 4 ounce doses in drinking water and repeated frequently a laxative action will often result. Magnesium sulphate is not a reliable purgative for the horse.

3. It is often prescribed twice daily in small doses in febrile diseases, administered in drinking water. It seems to lower the temperature, and stimulates the activity of the bowels.

4. As an alterative, in unhealthy conditions of the skin and in cutaneous affections. Its results are here questionable.

5. Antidote to poisoning by the salts of lead, which it converts into insoluble sulphates and also assists in their elimination.

6. Tetanus. Dawson and others have recommended epsom salts in the treatment of tetanus. They administer 20 mils of a 10 per cent. solution hypodermically every fifteen minutes.

Poisoning by Magnesium Sulphate. Very concentrated solutions of magnesium sulphate may not produce purgation, are then absorbed and are poisonous. The symptoms are: marked depression of the respirations, together with a curare-like action on the motor end plates in striated muscle. The antidotes, according to some authorities, are calcium and eserine.

SODII SULPHAS — SODIUM SULPHATE

Synonym. Glauber's Salt

This salt occurs as large colorless transparent prisms or granular crystals, odorless, bitter saline taste. Soluble in 2.8 per cent. of water. *Dose.* Same as for magnesium sulphate.

Sodii Sulphas Exsiccatus — Dried Sodium Sulphate. *Dose.* One-half that of sodium sulphate.

Its action and uses are similar to those of the previous drug, but it seems to give better service in horses. It is particularly serviceable in catarrhal icterus. It is not of so much benefit in lead poisoning as the magnesium salt. Sodium sulphate is recommended as an antidote to carbolic acid poisoning. It enters into the well known artificial Carlsbad salt (Sal Carolinum Factidum).

℞ Sodii Sulphatis ..... ℥ v
Sodii Bicarbonatis ..... ℥ ij
Sodii Chloridi ..... ℥ j
M. Ft. Pulvis.

OTHER SALINE PURGATIVES

Potassii et Sodii Tartras, Potassium and Sodium tartrate (Rochelle Salt), Magnesium oxide, Magnesium hydroxide (in the form of milk of magnesia) and the carbonate are very weak laxatives and rarely employed in veterinary practice.

Potassium Citrate and Bitartrate (cream of tartar) are mild laxatives, but are rarely used in veterinary medicine.

For Materia Medica of these salts, see respective elements, Potassium, etc., p. 347.

B. SO CALLED RAPID PURGATIVES

From our discussion of the actions of purgatives it will be evident that any drug which stimulates the vagus or motor nerve endings in the intestines will be capable of increasing peristalsis and producing purgation. From a number of agents which stimulate the nerve endings of the above mentioned nerves, the following are the only ones of importance:

Eserine (Physostigmine), Arecoline, Pilocarpine and one which produces purgation in an entirely different manner, Barium chloride.

These drugs are all discussed in detail in other places. Eserine p. 203, Pilocarpine p. 206, Arecoline p. 208, Barium chloride p. 357.

Briefly their uses are as follows:

PHYSOSTIGMINE — ESERINE

1. Myotic, See Myotics, p. 214.

2. Stimulant to involuntary muscle, as in impaction of the bowels to increase or stimulate peristalsis. Usually, or at least often, combined with pilocarpine to start the secretions as

℞ Eserinæ Sulph. .....grs. j
Pilocarpinæ Hyd. .....grs. iij
Aquæ (Sterilis) ..... ℥ j

In atonic conditions of the stomach and bowels and chronic intestinal catarrh, small doses frequently repeated are sometimes of benefit.

Contraindications.

1. Impactions and overdistentions of the stomach and intestines from undigested food. In this case it may cause rupture of the walls of the intestines and stomach. (It is often used, however, with gratifying results.)

2. In spasmodic colic, since it tends to increase the convulsive contractions of the bowels, consequently the pain is increased. There is also some danger of causing twist by the violent peristalsis.

3. In pregnancy eserine may cause abortion.

4. In tympanites and chronic indigestion of cattle eserine is not recommended by some, although it is the general opinion that it is a safe and efficient remedy in acute tympany.

Antidote. Atropine or hyoscyamine.

Caution: Since eserine and its salts decompose on exposure to the air, it is not suitable for hypodermic tablets. It should be purchased in hermetically sealed tubes. Solutions a week old have proved effective, but tend to deteriorate and assume a purple color. The salicylate is more stable than the sulphate.

Pilocarpine. This is indicated for the same conditions as eserine and usually combined with it. It has been recommended by some as an absorbent for serous exudates.

Contraindications.

1. It should not be given where the heart is weak. This also holds true in case of any of this group.

2. In pharyngitis and tetanus it is contraindicated because the animal swallows with difficulty and may even smother in its own saliva.

Arecoline Hydrobromide. This agent combines the action of the two preceding drugs.

Therapeutics. 1. Similar to the preceding for action on the bowels.

2. A specific for acute laminitis.

These drugs are administered hypodermically in most cases. Small doses may be given per os to small animals.

Barium Chloride.

This is a rapid purgative when given by mouth, and the most rapid of all purgatives when administered intravenously. It should not be given subcutaneously since it will form an abscess. Barium chloride is an intense irritant to the muscular system in general and to the gastro-intestinal tract. It will cause purgation in horses in one-half to an hour after administration in a drench; in one to two hours if administered in ball; and within a few minutes following intravenous administration. It has been recommended as a rapid-acting cathartic for horses in doses of 7½ to 15 grains (.5—1.) intravenously, and is the most rapid purgative known. It is believed that its purgative action following intravenous administration is due to its excretion in the intestines, which it irritates and thus causes increased peristalsis. A great many fatal results have followed the administration of this drug in such large doses and its use has been quite largely abandoned. Small or fractional doses are still used by some practitioners. In doses of one to two drams (4.—8.) per os barium chloride is followed by good results according to some practitioners. For more details of its action see Barium p. 357.

AGENTS ACTING UPON THE RECTUM

Enemata. These are rectal injections and may be employed for cathartic, nutritive or cleansing purposes. Furthermore, they may be used to expel gas or to carry remedies to the mucous membrane of the rectum and possibly colon in some animals.

The cathartic enemata may be further divided into softening agents for the feces and as purgatives.

The softening agents are water, soapsuds, glycerin, ox gall and olive oil. Hertz concluded that water was superior to olive oil, equal to ox gall, and that glycerin increased the penetration of the water. The best softening enema is probably normal saline solution 500, and glycerin 15. (1 pint—½ oz.).

The purgative enemata act either by irritating the rectum, or by mechanical means. The former consists of small amounts of fluid which contain aloes or some other irritant purgative, while the latter

consists of soap suds with the addition of ½ ounce (15 mils) of glycerin or oil of turpentine to each pint (500 mils).

Cannon, in working upon cats, found peristalsis of the small intestine as a result of rectal injection and antiperistalsis of the colon.

In tests with bland nutritive enemata, of milk, eggs, starch and bismuth subnitrate, he found, without exception, that antiperistaltic waves carried the material to the cecum. Small enemata never passed the ileocecal valve but large ones of the capacity of the large intestines would often pass into the small intestines.

It is interesting to note that in dogs and cats, it is possible to pass fluid through the entire digestive tract and to have it vomited. This is accomplished by injecting large amounts of saline into the rectum of a dog or cat, the animal in the meantime is held with the hind parts elevated. Some practitioners are using this treatment with apparent success in catarrhal conditions of the gastro-intestinal tract, and in food poisoning of the small animals. Where evacuations are to be produced quickly, the enema is given rapidly and by a sudden distention of the rectum or by direct irritation of the bowel-wall results reflexly in active peristalsis, accompanied by 6 ounces; tincture of asafœtida ½ ounce to each pint of water.

The following are most frequently recommended to expel gas. Soap suds (from strongly alkaline soap — laundry soap), of soap suds 1 pint — turpentine ½ ounce; or turpentine ½ ounce, olive oil 6 ounces; tincture of asafœtida ½ ounce to each pint of water.

Rectal or Colon Irrigations consist of saline solution slowly administered, two tubes are used, an inlet and outlet. The object is to clean out the bowels, stimulate the activity of the kidneys, or to supply fluid to the body.

Murphy recommended for post-operative tympanities and shock the continuous drop irrigation, in which an exceedingly small amount of saline is kept up day and night.

Nutritive Enemata. Sometimes it becomes necessary to prolong the life of the animal in those cases in which it is impossible to feed the animal through the mouth or inability of the animal to retain food in the stomach. The rectum should be cleaned about one-half hour before the food is to be administered. These foods must be warmed to body temperature and introduced high up but without unnecessary pressure. The early discharge may be somewhat prevented by pressing the tail to the anus or by the addition of opium to the enema. For herbivora, thin mashy material may be used. Common salt ½ per cent. is said to produce a reverse peristalsis, which may carry the food higher up and favors its absorption. The rectum should be washed once daily to carry out any decomposing refuse. The following amounts are recommended for one feeding, three to four times daily: Small dogs and cats, 10—

40 mils; large dogs, 100—200 mils; small ruminants, foals and calves, 200—400 mils; horses and cattle, 2000—3000 mils. (Jacob.)

It should be remembered that the mucosa of the rectum can only change starch and saccharose into glucose, but has considerable absorptive powers, and may therefore absorb water, salts, glucose, peptone, albumoses and other albuminoid bodies and small amounts of emulsified fats. The best adapted for dogs are milk, starch, glucose and raw eggs. The amount of glucose should not be over 2 per cent., of starch 8—10 per cent. of the total amount.

This enema is prepared by stirring starch and cold water and pouring this into boiling water in order to produce a starch jelly. To this is added glucose, previously dissolved in hot water. Finally two or three eggs stirred up in a little water and salt are slowly mixed with the cooled starch paste under constant stirring to insure a uniform mixture.

The digestion and absorption from the rectum of herbivora have not been studied with reference to the exact metabolism. *Hutyra and Marek.*

Rectal suppositories are made of soap, glycerin, wheat-gluten and plain or medicated cocoa butter. The evacuant suppositories act largely mechanically as a foreign body, stimulating the rectum to expel it. A piece of ice or an undisintegrated piece of soap will have the same effect. Those made of almost pure glycerin with enough sodium stearate to give a solid consistence are much used. According to Hertz, the glycerin acts as an irritant to the anal canal but not to the rectum.

Suppositories are most useful when the feces come back to the rectum but are retarded in their expulsion by a tight or sensitive sphincter.

8. ASTRINGENTS

Astringents are agents which cause constriction of the tissues by direct action. This action is largely due to the fact that they form compounds with the tissue elements which are soluble only under certain circumstances. In this way they precipitate albumen as the albuminate, tannate, etc. Some of these albuminates are insoluble in water, some soluble in an excess of the proteid, while the tannates are insoluble in water, but soluble in an excess of albumen, gelatin, or in acetic and lactic acids. The action of the astringents is most marked upon mucous membranes or raw surfaces. Some of them also have the power to check the secretions of glands, which is chiefly due to coagulation or precipitation of the proteids of the cells and some shrinkage of the cells by direct action. There may be some action

upon the bloodvessels supplying the glands, but this theory is not usually given much credence.

Astringents are divided into two great groups, the vegetable and mineral. The former derive their action from their tannic acid content, while the latter are for the most part metallic salts. Most astringents are also more or less irritant, especially if applied in concentration, while some of the metallic members of the group are more irritant than astringent. The irritation of the metallic astringents is due to various conditions. In one instance it may be due to the acid set free when the metal unites with the albumen of the tissues, in another, to a very permeable membrane formed by the salt, which does not prevent further action, and in still other cases to the very toxic action of the metal itself. A few of the mineral astringents appear to have a sedative or soothing effect. This is especially so of the bismuth salts, zinc oxide, and cerium oxalate.

General Uses. Astringents are used to 1, check diarrhea; 2, reduce inflammation of mucous membranes; 3, promote healing; and, 4, arrest hemorrhage.

1. *Check diarrhea.* In this case, the astringents seem to act by forming a deposit (tannates, albuminates) along the mucous membrane of the bowel, which prevents absorption and also the penetration of other irritant material, thus overcoming irritation and checking peristalsis, due to the irritation. At the same time they precipitate the proteids of the superficial cells of the mucous membrane, thus causing a shrinkage of the tissues and stoppage of secretion.

2. *Reduce inflammations of mucous membranes.* The mucous membranes most accessible for the application of astringents are those of the mouth, pharynx, conjunctiva, nose, genito-urinary tract and rectum. Tannic acid serves well in these cases, as also do the soluble salts of zinc, silver nitrate and alum. The usual strength for sprays and mouth washes are ½ to 1 per cent.; for the vagina or rectum, 1 to 2 per cent.; conjunctiva and nose, ⅛ to ¼ per cent.

3. *Promote healing.* For application upon open wounds, ulcers, etc., silver nitrate is very useful, then follow the soluble zinc salts and alum. They are usually employed in ½ to 5 per cent. solutions, but may also be used in dusting powders or in ointments (5 per cent.). Caution should be used in applying some of them, especially calomel and the lead salts as dusting powders, since they may be absorbed sufficiently to produce toxic effect. Zinc oxide is entirely safe and quite efficient.

4. *Arrest hemorrhage.* All metallic salts and tannic acid preparations arrest hemorrhage by precipitating the proteids, which stop up the lumen of the small vessels, in a manner similar to normal clotting by fibrin. This action will be discussed in detail under the head of styptics.

Principal members of the group of astringents are:

Vegetable Astringents.

Tannic acid	Geranium
Gallic acid	Hematoxylon
Galls	Rhois Glabra (Sumac)
Kino	Quercus (Oak bark)
Krameria	Hamamelidis
Gambir	Rubus

Mineral Astringents.

Alum	Salts of Copper
Salts of Iron	Salts of Bismuth
Salts of Lead	Salts of Silver
Salts of Zinc	Calcium Carbonate

ACIDUM TANNICUM — TANNIC ACID

Synonyms. Tannin, Gallotannic acid, Digallic acid

Tannin is the active constituent of all vegetable astringents. It is prepared from nutgalls, which contain from 30 to 60 per cent. It occurs as a light yellow amorphous powder, gradually turning darker when exposed to light and air, usually adhering in the form of glistening scales or spongy masses, odorless or of a feebly characteristic odor and astringent taste. It is soluble in 0.34 parts of water, 0.23 of alcohol in 1 part of glycerin, and almost insoluble in absolute ether, chloroform or benzine.

Preparations.

* *Collodium Stypticum* 20 per cent.
Glyceritum Acidi Tannici 20 per cent.
Unguentum Acidi Tannici 20 per cent. in benz. lard.
Trochisci Acidi Tannici, each 1 gr. of tannin.
B. P. *Suppositoria Acidi Tannici,* each 3 gr. of tannin.

Doses.

Acidum Tannicum. H. 3j—vj; 4.—25. D. gr. ij—vij; 0.13—0.5.

Action. Since tannic acid is changed to other products which do not have its characteristic action before absorption takes place, its action may be described as purely local. It forms a white precipitate with neutral solutions of gelatin, or albumen, which are entirely insoluble in water, but are soluble in an excess of gelatin albumen, lactic or acetic acids. Solutions of peptone are also precipitated unless in an acid medium. But if a proteid tannate is subjected to the action of the gastric juice, it is digested similarly to any coagulated proteid, but the acid is set free during the process of digestion and may precipitate other proteids, but this does not take place in the acid gastric juice.

* Unofficial.

If applied to animal tissues (as in making leather) which is chemically "gelatin tannate," the tissues tend to shrink together, become harder and firmer, and less subject to putrefactive changes. It is also more flexible than if simply dried. Strong solutions cause a dense precipitate of the proteids, which prevent the further penetration of the solution, while weaker solutions are thought to penetrate more deeply and give a more thorough precipitation of the proteids.

If applied to raw surfaces, tannic acid precipitates the albumen of the superficial cells and condenses the tissues just as explained above. There is some belief that it also diminishes the sensibility of the sensory nerves. It has a similar but stronger action when applied to mucous membranes and at the same time dries up the secretions by precipitating the proteids of the superficial cells. It coagulates blood in a similar manner and serves as a styptic.

When taken by the mouth, tannic acid or solutions of it have a bitter astringent taste, cause a sense of dryness and roughness of the mouth and interfere with the movements of the tongue. This action is due to a coagulation of the proteids in the epithelial cells and possibly to some shrinkage of the cells. The same feeling is produced in the throat and some discomfort and nausea, upon its reaching the stomach, are sometimes shown. Upon reaching the stomach it combines with any proteids there and precipitates them, but as the stomach contents become acid as digestion progresses, this combination is broken up, since tannin does not combine with proteids in an acid medium. Consequently the acid is free to act upon the walls of the stomach and intestine. These it affects in a similar manner to the mucosa higher up in the digestive tract. Moderate doses are usually followed by firmer feces and some constipation, while larger doses may sometimes cause diarrhea on account of the irritation.

Absorption and Elimination. Tannic acid is not absorbed as such. It is decomposed into gallic and pyrogallic acids in the intestines, is then absorbed and finally eliminated mainly by the kidneys, as these products. A little is absorbed as *sodium tannate* but the larger proportion undergoes complete oxidation. *None of the products into which it is decomposed have any astringent properties, so the action of tannic acid must be purely local.*

Therapeutics. 1. *Locally* to check excessive secretion and impart tone to relaxed mucous membranes. In subacute and chronic laryngitis, pharyngitis, swollen gums, etc. It is used in these conditions in solutions of from 1 to 5 grains to the ounce as a spray or wash. The glycerite may be of some service as an injection in chronic vaginitis, etc.

2. *Externally* in cases of excessive secretions upon wounds, ulcers, acute moist eczema, etc., and to toughen the skin. For this

purpose it may be used in solution, powder, ointment, glycerite. Styptic collodion may be of service.

3. *Hemostatic.* It is very efficacious in controlling hemorrhage from small vessels when it can be brought in direct contact with the bleeding surface. In cases of hematamesis it should be given in full doses by the mouth. Since it is not absorbed it is worthless in distinct hemorrhages.

4. *Antidote to poisons.* It is the chemical antidote to various metallic and alkaloidal poisons, since it precipitates these as the insoluble tannates. The precipitate should be immediately removed, however, as it is gradually dissolved by the fluids of the intestinal tract.

5. *Antidiarrheal.* Tannic acid is often used for diarrhea but it irritates the stomach, precipitates the albumen in the contents of the stomach and is destroyed before reaching the intestine, where it should produce its action slowly. For these reasons some of the crude drugs which contain tannin in combination with gums and resins (which retard their action) are to be preferred, i.e., preparations of Gambir, Kino, Krameria, etc.

ANTIDIARRHEALS

Antidiarrheals are remedies used to lessen peristalsis.

Diarrhea is due to digestive disturbances, bacteria, drugs or other irritant material. The treatment therefore should be

1. To remove the cause or irritant material by use of purgatives.
2. To control the production of the irritation by antiseptics and reduction of the diet.
3. Neutralization of the causative factor if possible. If due to acid formation the alkalies work exceedingly well. Chalk, calcium phosphate, lime water or charcoal.
4. To check peristalsis by:
   a. Heat to abdomen or hot drinks.
   b. Astringents.
   c. Drugs, checking peristalsis and secretions by direct action upon the nerves (opium and belladonna).
5. Treat the weakness by giving stimulants, camphor, alcohol, etc. The chief astringents used in diarrhea are:

Vegetable	*Mineral*
Tannin, etc.	Salts of bismuth
Kino	Zinc oxide
Catechu	Silver nitrate
Gambir	

The Sun Cholera Mixture has been recommended as combining the above actions and is very effective in many instances. Its ingredients are

Sun Cholera Mixture.

℞ Tincturæ Rhei.
Tincturæ Opii.
Tincturæ Capsici.
Spiritus Camphoræ.
Spiritus Menthæ Piperitæ āā. equal parts.

Dose. 10 drops to a teaspoonful, for a dog with diarrhea. Horses and cows. ʒj—ij; 30.—60.

Since diarrhea has so many causes, remedies of entirely different action may be required. In the simple fermentative type, a purgative like castor oil, followed by a protective such as the bismuth salts, may be indicated.

In severe cases camphor, lead acetate or opium may be the desired remedy. The remedies most often used are the astringents, mineral and vegetable, camphor, opium, castor oil and rhubarb.

Several combinations have proved quite generally useful, such as Sun Cholera Mixture, N. F., Squibb's Diarrhea Mixture, N. F. The following prescriptions may be useful:

Squibb's Diarrhea Mixture.

℞ Tincturæ Opii.
Spiritus Camphoræ.
Tincturæ Capsici .....āā ♏ xij; 0.8
Chloroformi ..... ♏ v; 0.3
Alcoholis q. s. .....ad. ʒ j; 4.

Dose. H. 1 to 2 ounces. D. ½ dram.

Diarrhea puppy or cat.

℞ Bismuthi Subnitratis ..... ʒ iij; 12.
Tincturæ Opii Camphoratæ ..... ʒ iv; 15.
Misturæ Cretæ q. s. .....ad. ℥ ij; 60.
Sig. One-half teaspoonful to dessertspoonful after each movement of the bowels according to size.

℞ Tincturæ Opii.
Tincturæ Rhei.
Tincturæ Catechu (Gambir).
Spiritus Menthæ Piperitæ .....āā. ʒ j
Bismuthi Subnitratis ..... ʒ j
Shake and give 10 drops to teaspoonful to dog with intestinal catarrh. Larger doses for the horse. ℥ ss–ij.

TANNIGEN — TANNOFORM, TANOCOL, ETC.

Many efforts have been made to improve the action of tannin. The main objects sought have been to get a preparation that would not be acted upon in the stomach, and one that would produce a rather slow but continuous action upon reaching the intestine. These attempts have resulted in the so-called artificial tannins which

are insoluble in water and dilute acids but soluble in alkalies. They are all obtained by the precipitation of proteids with tannin.

Tannalbin is a light brown, tasteless, odorless powder containing about 50 per cent. of tannin. It is nothing more than a dried tannin albumen precipitate. **Tannocol** is a similar gelatin precipitate, while **tannigen** is the acetic ester of tannic acid (acetyl tannin). **Tannopin** is formed by a combination of hexamethylenamine (urotropin) and tannin. **Tannoform** is a similar compound of tannin with formaldehyde. These are all yellow powders, odorless, tasteless and incompatible with alkalies. They are all used for their local action upon the intestines, are less liable to produce irritation than tannin and may be used interchangeably. Tannoform and tannopin may also be used as astringent dusting powders upon open wounds either alone or in combination with starch 1—5. They are indicated particularly in acute intestinal catarrh after the cause of the disease has been entirely removed. Their doses are about twice that of tannic acid.

ACIDUM GALLICUM — GALLIC ACID

This is the hydrid of tannic acid. It occurs in many plants usually along with tannin. It is prepared by boiling tannic acid with weak acids, occurs as pale fawn colored, silky needles, odorless, of an astringent taste, and permanent in air. It is soluble in 83.7 parts of water, 4.14 parts of alcohol, and 12 of glycerin. It differs from tannic acid in not precipitating gelatin or albumen.

Action and Uses. Externally it is an astringent but much weaker than tannic acid. It does not coagulate blood so cannot serve as a styptic. Gallic acid has been recommended as a hemostatic in hemorrhages that can be reached by the circulation but its reputation for this action is entirely without foundation as it is absorbed and eliminated unchanged and does not possess such an action even when applied locally. It is occasionally of service in reducing the amount of urine in diabetes insipidus or polyurea.

It is incompatible with ferric salts, tartar emetic, lead acetate, silver nitrate and spirits of nitrous ether.

Doses same as tannic acid.

GALLA — GALLS

Synonyms. Nut Galls, Smyrna Galls

Nutgalls is the excresences on the leaves of an oak, *Quercus infectoria,* caused by the punctures and deposited ova of a wasp (*Cynips tinctoria*). This particular oak grows in countries bordering on the Mediterranean. The activity is due to tannic acid of which it contains from 30 to 60 per cent.

Preparations and Doses.

Galla ℥ ij—iv; 8—16.
* Tinctura Gallæ 20 per cent.
Unguentum Gallæ 20 per cent.
* Unguentum Gallæ cum Opii B. P. 7½ per cent. opium.

Galls and its preparations are little used internally. The ointment with equal parts of stramonium ointment or as the British official is often very serviceable in painful hemorrhoids.

KINO

Kino is official as the spontaneously dried juice of *Pterocarpus Marsupium,* a large tree of India.

Preparations.

Kino H. ℥ ss—j; 15.—30. D. gr. v—xxx; 0.3—2.
Tinctura Kino D. ℥ ½—j; 2.—4.
* Fluidextract H. ℥ ss—j; 2.—4. D. xv—xxx; 0.3—2.
* Tinctura Kino Compositus B. P. 5 per cent. of opium.

* KRAMERIA

Synonym. Rhatany

This is the root of *Krameria triandra,* a low shrub of the mountains of Peru and Bolivia. It contains about 20 per cent. of a peculiar tannic acid, "Krameria-tannic acid."

Preparations.

* Extractum Krameriæ. A dried watery extract. H. ℥ ij—iij; 8.—12. D. grs. v—x; 0.3—0.6.
* Fluidextractum Krameriæ. H. ℥ ss—j. D. ♏ v—xx; 0.3—1.3.
* Tinctura Krameriæ. H. ℥ j—ij. D. ℥ ss—ij.
* Syrupus Krameriæ 45 per cent. of fluidextract.
* Trochisci Krameriæ each 1 grain.

GAMBIR

This is an extract prepared from the leaves and twigs of *Ourouparia Gambir,* a climber of the East Indies. It was introduced into the pharmacopœia of 1890 to replace catechu on account of the scarcity of that drug. It contains from 33 to 47 per cent. of catechu-tannic acid, catechin, etc.

Preparations.

Gambir. Double those of Tannic acid.
Tinctura Gambir Compositus (5 per cent. of gambir, 2.5 per cent. of Cinnamon). Dog. ℥ ss—j; 2.—4.
* *Trochisci, Gambir.* Each 1 grain.

* Unofficial.

CATECHU B. P.

This is the extract of leaves and shoots of *Uncaria Gambir.* Contains about 45 per cent. of catechu-tannic acid. It has been replaced in the U. S. P. by the preceding. Dose same as Gambir.

The above mentioned drugs are similar in action, all contain large amounts of tannic acid to which their action is due. They are often preferred to tannic acid in diarrheas as their action is brought about more slowly and is more lasting. This difference in rapidity and persistence of action from tannin is due to the presence of gums and resins, in the preparations of the crude drugs, which retard the breaking up of the acid content. They should never be used in the early stages of diarrhea, until the irritant has been completely removed by a purgative or unless purgation persists after the removal of the irritant. They are often prescribed with chalk or opium as in the following formula:

Diarrhea.

℞ Tincturæ Opii .....ℳ xx– 1.3
Cretæ Præparatæ ..... ʒ ij – 8.
Tincturæ Krameræ ..... ʒ ij – 8.
Acaciæ q. s.
Aquæ Cinnamomi q. s. .....ad. ℥ iij–90.
M. et Fiat Solutio.
Sig. Dram doses for dog. Ounce or two ounce doses for horse every 2 to 3 hours.

* GERANIUM

Synonym. Cranesbill

This is the rhizomes of *Geranium Maculatum,* a perennial of the woody places of North America. It contains from 10 to 28 per cent. of tannic acid.

Action and Uses. It is equivalent in action and uses to the preceding drugs but is more agreeable.

Fluidextractum Geranii. D. ℳ x—xxx; 0.6—2.

* HEMATOXYLON

Synonym. Logwood

The heart wood of *Hematoxylon Campechianum,* a small tree of Central America and the West Indies. It contains tannic acid and a crystalline red coloring principle, hematoxylin.

Extractum Hematoxyli. Evaporated watery decoction. H. ʒ ss—iv; 2.—15. D. gr. v—xv; 0.3—1.

Fluidextractum Hematoxyli. H. ℥ ss—ij; 15—60. D. ℳ xv—xlv; 1.—3.

* Unofficial.

This is used as an astringent in the diarrheas of the young. It is less active than kino, krameria, or gambir, but more pleasant on account of its sweetish taste. The coloring matter is eliminated by the urine which it stains red. This coloring matter is not used in medicine.

* RHUS GLABRA

Synonym. Sumac

This is official as the fruit of *Rhus Glabra,* a shrub growing in the waste places of North America. It contains from 6 to 27 per cent. of tannic acid and several mallates.

Fluidextractum Rhois Glabræ. D. ♏ xxx—lx; 2.—4.

Uses. This drug is never used internally but the fluid extract diluted with 6 to 8 parts of water is an efficient mouth wash in stomatitis and acute pharyngitis. It is frequently prescribed with small amounts of potassium chlorate as in the following prescription.

Mouth wash.

℞ Potassii Chlorati ..... ʒ j; 4.
Fluidextracti Rhois Glabræ ..... ʒ j; 30.
Aquæ q. s. .....ad. ʒ viij; 250.
Use as wash in stomatitis or pharyngitis.

* QUERCUS

Synonym. White oak bark

This is the bark of the ordinary white oak, *Quercus alba,* a tree indigenous to North America, east of the Mississippi. It contains 5 to 10 per cent. of tannin and a bitter, quercin.

Uses. Used entirely externally. Usually as a decoction in the strength of ℥ j to O.j of water, as an injection in leucorrhoea, pharyngitis, etc.

* HAMAMELIS

Synonym. Witch-hazel

This is official as the folia (leaves) and cortex (bark) of *Hamamelis Virginiana,* a widely distributed shrub of North America. It contains tannin and a volatile oil.

Preparations.

From the leaves.

* *Fluidextractum Hamamelides Foliorum,* 8 per cent. tannin. H. ℥ j—ij; 30.—60. D. ʒ ss—ij; 2.—8.

From the bark.

* Unofficial.

Aqua Hamamelidis, a watery distillate to which is added 15 per cent. of alcohol.

The fluidextract contains tannin, a volatile oil and a bitter. Witch hazel has been variously claimed to be an astringent, hemostatic, and sedative, but these claims have not been based upon experimental data. The water is a household remedy for the treatment of burns, strains, bruises, etc., but it appears that its action is overrated. It is sedative to painful hemorrhoids. Both preparations have been recommended for internal hemorrhages but it is of exceedingly doubtful value.

* RUBUS

Synonym. Blackberry

The bark of the root of *Rubus Villosus, nigrobaccus* or *cuneifolius.*

The syrup and fluid extract were formerly official. The doses of the former are D. ♏ x—lx, and the latter, ♏ x—xx.

Rubus is simply used as a substitute for other astringents in intestinal catarrh.

The mineral astringents will be discussed in another place.

ASTRINGENTS

Diarrhea in Foals up to a Week Old.

℞ Olei Ricini ..... ℥ j
Mucilaginis Acaciæ q. s.
Olei Piperitæ ..... ♏ v
Aquæ q. s. ..... ad. ℥ ij
M. Ft. Haustus.
Sig. Give at one dose. In older foals double the quantity of castor oil.

Persistent Diarrhea in Foals.

℞ Catechu ..... ℥ iij
Cretæ Præparatæ ..... ℥ iij
Spiritus Ammoniæ Aromatici ..... ℥ ij
Tincturæ Opii ..... ℥ j
Aquæ Menthæ Piperitæ q. s. ..... ad. ℥ xij
M.
Sig. Give one to two ounces as needed in a little of the mare's milk. *Hoare.*

Diarrhea in Cattle.

℞ Opii ..... ʒ vj
Catechu ..... ʒ ij
Cretæ Præcipitati ..... ℥ iij
Zingiberis ..... ℥ iij

* Unofficial.

M. Divide in Chart. No. 3.
Sig. One every twelve hours in a pint of flour gruel until diarrhea ceases.

Diarrhea in Puppies.

℞ Bismuthi Subnitratis ..... ʒ ij
Tincturæ Opii Camphoratæ ..... ʒ j
Mucilaginis Acaciæ ..... ℥ jss
Aquæ Chloroformi q. s. .....ad. ʒ iij
M.
Sig. One-half to one teaspoonful every three hours until diarrhea is checked.

9. ANTHELMINTICS — WORM REMEDIES

Anthelmintics are agents used to kill or expel intestinal parasites. They are sometimes divided into vermicides which kill the parasites, and vermifuges which expel them, but for practical purposes this distinction is unimportant. According to this method of division they may be grouped as follows:

Vermicides.

Aspidium	Kamala	Thymol
Chenopodium	Turpentine	Beta-naphthol
Cusso	Pepo	Antimony and Potassium Tartrate (Tartar Emetic)
Granatum	Santonin	
Quassia		Chloroform

Vermifuges.

Calomel	Spigelia	Hydrogogue Cathartics

Vermicides may be further divided according to the particular type of worm for which they are effective, as,

Tænicides (Tapeworm remedies).

Aspidium	Cusso (Kusso)
Granatum (Pelletierine)	Turpentine
Kamala	Areca Nut
Pepo	Chloroform

Hook Worms (Uncinaria).
Thymol, Beta-naphthol and Chenopodium.

Round Worms (Santonin Group).

Santonin	Turpentine
Spigelia	Calomel
Chenopodium	Tartar Emetic
Chloroform	Hydrogogue Cathartics

Pin Worms (Oxyures).
Santonin or other vermicide per os, followed by enemata of quassia, vinegar, lime water or solution of sodium chloride.

There are many drugs not included in the above groups which are occasionally used as anthelmintics but as they possess other more important and typical actions they are discussed in other places. Only those drugs which have no other therapeutic action will be discussed here.

Action of Vermicides and Vermifuges. The ideal anthelmintic should kill or stupefy the parasites but not irritate the gastro-intestinal tract of the host or be absorbed in sufficient amount to produce harm to the host. No such parasiticide has as yet been found that fulfills these requirements and all are capable of producing disastrous effects if not used cautiously and none of them is of certain action upon the parasite. The remedy, however, must be capable of penetrating the outer covering of the parasite, so that volatile poisons whose vapors permeate the intestinal canal, penetrate the covering of the parasite and kill or stupefy it, before absorption takes place by the host, fill this requirement. In many cases the absorption is retarded by the presence of a fixed oil which exists along with the volatile oil. A volatile parasiticide is often combined with a fixed oil simply to retard the absorption of the anthelmintic. On the other hand preparations of volatile substances are always unstable and some uncertainty always accompanies their use.

In some cases the parasite seems to show a peculiar susceptibility to certain poisons. For instance, pelletierine in very dilute solution (1—10,000) will kill tape worms, while santonin is more toxic to the round varieties.

Active catharsis is a factor in the removal of the parasite but is not sufficient alone, because, if in good condition, the worms are able to move against peristalsis or to attach themselves to the walls of the intestines.

Before the administration of a vermicide the intestinal canal should be emptied so far as possible by fasting the animal for from 12 to 24 hours or by allowing only a light easily digested diet. This procedure weakens the worms and prevents the contents of the intestines from diluting the medicine or protecting the worms. A purgative should always accompany or follow an anthelmintic because the worms are rarely killed and would recover if left in the intestine. Croton and castor oil are often prescribed as the purgative although, according to Poulsson, castor oil should not be administered with aspidium because it tends to aid its solubility and absorbability. Other authorities dispute this and claim that oils aid in the solution of the active principles; but the records show that in most cases of poisoning in man, the remedy has been administered with or followed by castor oil.

TÆNICIDES

ASPIDIUM

Synonyms. Male Fern, Male Shield Fern, Filix Mas

Parts Used. The dried rhizomes of *Dryopteris filix mas* and *Dryopteris marginalis,* ferns indigenous to North America, a portion of South America, Northern Asia and portions of Africa. It contains a fixed oil, a volatile oil, a resin and filicic acid, besides a number of neutral and acid bodies chief of which are Aspidinin, Flavospadic Acid, Albaspidin and Aspidinal (Boehm) to which Kraft has added Filmaron and Flavaspidinin. All the principles appear to be necessary but it is generally believed that filicic acid is the most toxic to tænia, and therefore the most active part of the drug. This changes in time to its inert anhydrid filicin.

Preparations and Doses.

Oleoresina Aspidii. H. ℥ iij—vj; 12.—24. D. gr. xv—xc; 1.—6. Cat. iij—viij; 0.2—0.5.

Action. When administered as a vermicide there is usually no symptom except the expulsion of the worm. However, if toxic doses are given or if the drug is administered in castor oil or other substances which aid its absorption it may produce poisonous symptoms manifested especially by nervous phenomena and gastro-intestinal disturbances. There may be nausea, vomiting, colicky pains and diarrhea. These are associated with nervous disorders, as depression, coma, increased reflexes, weak pulse, superficial respirations, convulsions and collapse together with temporary blindness due to paralysis of the retina.

Therapeutics. As a tænicide especially for the unarmed variety, although it is used with good results against both varieties of the parasite.

2. As a parasiticide in the treatment of follicular mange.

Administration. Aspidium should be administered in a capsule or pill upon an empty stomach and followed by a purgative. It may be necessary to anesthetize the stomach with cocaine (½ grain in 20 minims of water) to prevent vomiting. It is often advantageously combined with some other tænicide, such as areca nut, kamala, or turpentine.

The following prescriptions are representative of its use:

No. 1. Tapeworms in Dog.

℞ Oleoresinæ Aspidii ..... grs. xxx
Arecæ Seminis ..... ℥ jss
Chloroformi ..... ♏ xv
Mucilaginis Acaciæ ..... ℥ j
M. Ft. Solutio.

Sig. Give at one dose. Follow with a purgative. Repeat treatment in 48 hours if necessary.

No. 2. Follicular Mange, Dog.

℞ Oleoresinæ Aspidii ..... 50.
Creolini ..... 50.
Balsami Peruviani ..... 75.
Alcoholis ..... 500.
M. Ft. Sol.
Sig. Apply once daily to affected parts or one-third of the body.

GRANATUM

Synonyms. Pomegranate, Granatum Cortex, Pomegranate Bark.

Parts Used. The bark of the stem and root of *Punica Granatum,* cultivated in subtropical countries.

Constituents. Pomegranate contains two active liquid alkaloids, Pelletierine or Punicine and Isopelletierine. Besides these there are also two less active alkaloids and a large amount of tannic acid (punico-tannic acid). Pelletierine tannate U. S. P. is a mixture in varying proportions of the tannates of four alkaloids (punicine, isopunicine, methyl-punicine and pseudo-punicine), obtained from pomegranate. It should be kept in small well-stoppered, dark amber-colored vials.

Doses.

Granatum. D. 3 ss—ij; 2.—4.
Fluidextractum Granati 3 ss—ij; 2.—4.
Pelletierinæ Tannas. D. grs. ij—iv; 0.13—0.26.

Local Action. Externally and locally it is astringent on account of the large amount of (punico) tannic acid present but is never used for this action.

Internally. Small or medicinal doses show no appreciable effect upon the animal except some slight nausea, in animals which vomit, and the passage of the worm. Large doses of the crude drug, especially, are followed by gastro-intestinal irritation, shown by abdominal pain, nausea, vomiting and purging. This action is largely due to the tannic acid contained in the crude drug and consequently the administration of the alkaloid is not attended by so much irritation.

There are also exhibited after administration of large doses, certain nervous disturbances, consisting of increased reflex excitability, dullness, loss of coordination and weakness of the limbs. Pelletierine and isopelletierine have a specific action upon tape worms. Schroeder found that a 1—10,000 solution would kill them in 10 minutes, while even stronger solutions had but little if any effect upon other intestinal parasites.

Therapeutics. Granatum and its alkaloids are used entirely as a remedy against tapeworms.

Administration. A decoction of the fresh grated or ground bark, ½ dram in 8 ounces of water, may be used, but since this is liable to produce undesirable results, *see above,* and as the alkaloids are liable to decompose unless the bark is fresh, the alkaloidal salt should be preferred. If the alkaloid (pelletierine) is used, it should be given with four times its weight of tannic acid. Animals should be treated the same as in case of aspidium, before administering the drug, and a purgative should be given within ½ to 2 hours after the administration.

* KAMALA

Synonym. Rottlera

Parts Used. The glands and hairs from the capsules of *Mallotus philippinensis,* a small tree indigenous to India, China and the Philippines. The active principle appears to be rottlerin.

Action and Uses. Kamala is irritant to the gastro-intestinal tract often causing vomiting. It also possesses strong purgative action, so need not be combined with or followed by a purgative. Its action is usually produced within 5 hours.

It is used entirely as a remedy against tapeworms.

Doses. Swine and Dogs. ʒ ss—ij; 2.—8. Lambs. ʒ j; 4. Cats gr. x—xv; 0.6—1.

Administration. It should be given in milk, honey, syrup, infusion or capsule. If given in solution to dogs or cats, it should be administered through a stomach tube.

℞ Kamalæ ..... ʒ ijss
Arecæ Seminis ..... ʒ v
Olei Theobromatis q. s.
Fiant pilulæ No. xxv.
Obduce Keratino.
Sig. 6–15 pills for a dog.
(Schiel).

℞ Oleoresinæ Aspidii.
Kamalæ .....āā. ʒ ss–ij
Ft. Capsulæ No. 2.
Sig. Give both at one dose to a dog with tapeworms.

* CUSSO

Synonym. Kousso, Brayera

Parts Used. The female inflorescence of *Hygenia abyssinica,* an ornamental tree in Abyssinia. The male flowers of the tree are strongly emetic but are not used in medicine.

* Unofficial.

Doses. Sheep and Swine. ʒ ss—ij; 15.—60. Lambs. ʒ j—ij; 4.—8. Dogs. ʒ j—ij; 4—8.

Action and Uses. Kousso contains a yellow amorphous active principle, kussotoxin, a resin and a volatile oil. The first mentioned is probably the most active. It has no appreciable effect except to cause nausea in medicinal doses. Overdoses resemble those of aspidium. Its only use is that of a tænicide. It is usually not necessary to follow with a purgative but should be followed by one if purgation does not take place within 6 to 8 hours.

PEPO

Synonym. Pumpkin Seed

Parts Used. This is the seed of the common pumpkin (*Curcurbita Pepo*).

Action and Uses. The seeds contain a fixed oil and a resin. They have been used with good results as a tænicide and by some are given second place to aspidium. Power and Salway were unable to find any tænicide properties in the seeds. Pepo has no appreciable effect upon animals even in large doses and the only therapeutic use is that of a tænicide.

Dose. D. ʒ j—iij; 30.—90.

Administration. The seed should be suspended in an emulsion, made into an infusion, or beaten into a paste with sugar and diluted with milk. They should be followed by a purgative.

Early Bird Tapeworm Remedy. *Human.*

℞	Peponis	ʒ ij;	8.
	Granati.		
	Cusso āā.	ʒ j;	4.
	Aquæ Bullentis q. s. ad.	ʒ j;	30.
Ft.	infusum, cole et add.		
	Oleoresinæ Aspidii	ʒ j;	4.
	Kamalæ	ʒ j;	4.
	Glycerini	ʒ iv;	2.
	Mucilaginis Acaciæ	ʒ ss;	2.
	Aquæ q. s. ad.	ʒ viij;	240.

Misce et fiat solutio.

Sig. One-half statim, one-half in three hours.

OTHER TÆNICIDES

Turpentine. This drug is discussed in detail on page 301. It has long been used as a vermicide against both varieties of worms, but on account of its irritant action upon the stomach and kidneys is not used so much as formerly. It answers fairly well for horses and hogs. It should be given to the former in raw linseed oil and to the latter in milk. As a remedy against tapeworms it is usually

combined with Aspidium. Turpentine is too irritating to the stomach and intestines to be of service in canine work unless properly diluted or combined with other drugs. See after Chenopodium.

Chloroform, Thymol and Betanaphthol have not been used sufficiently to determine their value as tænicides.

ROUND WORM GROUP

Many of the remedies used against tapeworms are also effective for the round varieties. The same dietary measures and subsequent purging should be followed as outlined under tapeworms.

* SANTONICA

Synonyms. Levant Wormseed, Cinæ Flores

Parts Used. The dried unexpanded flower heads of *Artemisia pauciflora,* a perennial shrub of Turkestan. The dose for the dog is 10—60 grains but the use of the crude drug has been practically abandoned in favor of its glucoside, santoninum.

SANTONINUM

Synonym. Santonin

Properties. This occurs as colorless crystals when first prepared but assumes a yellowish color on exposure to light. This, however, does not seem to affect its activity to any appreciable extent but should be avoided by keeping santonin in amber colored bottles.

Doses. H. 3 j—ij; 4.—8. D. gr. j—iij; .065—0.2. Cat. $\frac{1}{10}$—$\frac{1}{2}$; 0.006—0.03.

Preparation. * Trochisci Santonini. Each contains ½ grain of santonin.

Action. Santonin in moderate doses has no appreciable physiological action upon the host. It is probably the best remedy we possess against round worms but is not so effective for the tape or hook worms. The action of this drug is not well understood. When worms are placed in solutions of it they do not die but move more vigorously. It is generally believed to be very irritating to them but not necessarily fatal and that santonin drives the worms to the large intestine from which they may be easily removed by a purgative. They are often expelled in a very active condition.

Santonin is practically insoluble in water but undergoes some change in the digestive tract so that part is absorbed and in some cases peculiar conditions are produced even by small doses. The most common symptoms following its administration in man is a disturbance in vision (xanthopsia) or yellow vision, so that every-

* Unofficial.

thing appears to have a yellow color. Santonin is excreted by the kidneys and intestines. Small doses impart a yellow color to the normal urine and in some pathological conditions, with a strongly alkaline urine, as in cystitis, may produce such a deep color as to suggest hematuria.

Large doses are dangerous and may be fatal. The symptoms are quite uniform in animals so that only those seen in the dog will be described. The first distinct symptom in this animal is a twitching of the muscles of the head, followed by rolling of the eyes, grinding of teeth, rotation of the head, together with flexion and extension of the neck. Later epileptiform convulsions occur with the body first in opisthotonus, followed by clonic spasms of the limbs and trunk. Intermittent with the spasms are periods of rest during which a peculiar contraction of all the muscles may be seen. The respirations are disturbed during the convulsions and asphyxia may occur in fatal cases. Temporary blindness may follow (Cushny).

Treatment. Empty the stomach with an emetic or stomach pump, then administer large doses of epsom salts. Control the convulsions with ether or chloroform.

Therapeutics. Santonin is used almost entirely as a remedy for round worms in the dog and cat, as its price prohibits its use to any extent in the large animals. The bowels should be emptied before its administration and the drug should be followed by a purgative to carry out the sick worms. Calomel is frequently administered with santonin as it is believed to increase the action of that drug. Others recommend its use with castor oil.

The following prescriptions are representative of its use:

For Dogs.

No. 1.

℞ Santonini 0.3
Olei Olivæ 50.0
Solvi Leni Calore.
Sig. Teaspoonful for small. Tablespoonful for large, 3 or 4 times daily.

No. 2.

℞ Santonini.
Hydrargyri Chloridi Mitis .....āā. gr. ss
M. Ft. Pillulæ.
Sig. One tablet every 3 hours for 3 doses, followed by a dose of castor oil.

No. 3. For Hogs.

℞ Santonini ..... grs. viij
Hydrargyri Chloridi Mitis ..... grs. v
M. et Ft. Pulveris. For 100 pounds of swine.
Sig. Mix well with the feed, give two doses daily for two days, then skip a few days and repeat.

* CHENOPODIUM

Synonym. American Wormseed

Parts Used. The fruit of *Chenopodium ambrosioides anthelminticum,* a perennial herb grown in the United States and the West Indies. It contains a volatile oil (Oleum Chenopodii) to which its action is due.

Doses.

Chenopodium. H. not used. D. grs. xv—xxx; 1.—2.
Oleum Chenopodii. H. ♃ j—iij; 4—12. D. ♏ j—vij; 0.065—0.5. Cat. ♏ ss—iij; 0.03—0.2.

Action and Uses. Both the powdered drug and the oil are efficient anthelmintics when used against round worms and hook worms. The oil is used almost exclusively and should be given upon sugar, made into an emulsion, or in capsules, three times daily, followed by a cathartic every other day. Oil of chenopodium has been used successfully in the treatment of hook worms in man.

℞ Olei Chenopodii .....ms. xvj
Olei Terebinthinæ .....ms. ij
Olei Anisi .....ms. xvj
Olei Ricini ..... ℥ iijss
Olei Olivæ ..... ℥ iij
M. et heat gently.
Sig. Full sized or medium puppies under six weeks one-half teaspoonful in a little milk. Six weeks old, one teaspoonful. Eight weeks old, one teaspoonful repeated in one hour. For small or toy puppies reduce the dose to ¼–½ the above.

Follow with a purge in each case if the bowels do not move in one hour. Repeat in a few days if necessary. *Hoare.*

SPIGELIA

Synonym. Pink Root

Parts Used. The rhizomes and roots of *Spigelia marilandica,* a perennial herb growing in southern United States.

Constituents. It contains a volatile oil, tannic acid, a bitter principle, and an alkaloid, spigeline.

Preparations and Doses.

Fluidextractum Spigeliæ. Mature Dogs. ♏ xv—iv; 1.—4.

Action. Spigelia is a reasonably safe and efficient remedy for round worms if reasonable care is taken in its administration. Toxic doses cause excitement, swelling of the eyelids, dilatation of the pupils, dimness of vision and stupor. It should always be combined with a brisk cathartic as in the following prescription:

* Unofficial.

℞ Fluidextracti Spigeliæ.
Fluidextracti Sennæ.
Syrupi Aurantii.
Syrupi Glycyrrhizæ .....āā. ♏ xxx
M. Ft. Solutio.
Sig. Every other morning for three doses for a medium sized dog.

* SEMEN ARECÆ

Synonyms. Areca nut, Betel nut, Areca catechu

Parts Used. The fruit of *Areca catechu,* an East Indian tree belonging to the family of palms.

Constituents. Areca nut contains three alkaloids, arecoline, arecaine, and traces of guvacine together with a considerable amount of tannic and gallic acids, a fixed oil, volatile oil and a gum. Arecoline is the most important constituent and is present in about the proportion of 0.1 per cent. in the crude drug. It occurs as a colorless, volatile, oily liquid and forms soluble salts with acids. The hydrobromide (Arecolinæ Hydrobromidum) is the one most used. This salt is permanent in air and in aqueous solution retains its action for several months.

Arecoline has been discussed on p. 208.

Doses. Horses. ʒ iij—viij; 100.—250. Foals. 3ijss—ʒij; 10.—60. Dogs. 3 j—ijss; 5.—10. Sheep and Swine. 3 j—iv; 5.—15. Cats. 3 ss—j; 2.—5.

Action and Uses. Areca nut is an anthelmintic for all animals but especially for dogs suffering from either tape or round worms. The worms are usually expelled in from 3 to 5 hours. This drug has no physiological action except that of a weak astringent on account of the large amount of tannic acid it contains, and some irritation of the stomach which causes nausea and vomiting unless given with care. It is not considered very safe for young puppies, for dogs in a weak condition or for cats.

Administration. Areca nut should be freshly ground or grated in all cases. It should be administered to dogs and cats in capsule, keratin coated pills or mixed well with butter to prevent nausea and vomiting. The usual dose for the dog is 1—2 grains per pound of body weight and slightly less for cats. It should be preceded and followed by a purgative in these animals.

Fuchs recommends the drug for tapeworms in the horse. He prescribes or dispenses 1000.0 gm. (2 lbs.) and directs that two tablespoonfuls be given three times daily in feed. Claussen recommends it in daily doses of 15.0—20.0 gm. (3 iv—v) for ascarides in six months old foals, while Fröhner has found it safe in daily doses of 250.0 gms. (ʒ viij) for horses and 500.0 gms. (ʒ xvj) for cattle. Some clinicians have recommended the alkaloid (arecoline hydro-

* Unofficial.

bromide) as a vermicide for both round and tape worms of dogs in oral doses of 1/12—1. grain. The larger doses, however, cause a considerable amount of depression and pain and at the same time are not always successful. The following prescriptions illustrate its use:

No. 1. Dog.
℞ Seminis Arecæ ..... ʒ ijss; 10.0
Olei Theobromatis et.
Ceræ Flavæ q. s.
M. Ft. Pilulæ No. XX.
Abduce Keratino.
Sig. Give at one dose for a dog with tapeworms.

No. 2. Dog.
℞ Seminis Arecæ ..... ʒ v; 20.
Kamalæ ..... ʒ ijss; 10.
M. Ft. Capsulæ No. IV.
Sig. Give at one dose to a large dog with tapeworms.

No. 3. Sheep.
℞ Seminis Arecæ ..... ℥ ij; 60.0
Arseni Trioxidi ..... ʒ j; 4.0
Sulphuris ..... ℥ ij; 60.0
M. Ft. Chartulæ No. VI.
Sig. One in salt each day for 20 yearlings.

No. 4. Lambs.
℞ Seminis Arecæ ..... ʒ j
Aquæ ..... ℥ ij
M.
Sig. Shake and give such a dose to each lamb.

No. 5. Horses.
℞ Seminis Arecæ ..... ℔ ij
Sig. 2 tablespoonfuls three times daily in feed.
Fuchs.

FOR HOOK WORMS — UNCINARIA

Thymol. This is probably the best agent for the treatment of uncinaria (hookworms). It is described in detail in another place p. 458. It should be given in daily doses of 10—30 grains, average for the dog, 10 grains. The animal undergoing treatment should be closely observed and upon the appearance of any undesirable symptoms the drug should be withdrawn. Some recommend a good dose, one day each week, preceded and followed by a purgative.

Betanaphthol has given good success in some cases. It should be given the same as thymol but in half the doses. It is dangerous for dogs and cats.

Oleum Chenopodii has been used with some success in human practice but has not been proved serviceable in veterinary medicine.

PINWORMS (OXJURES)

Treatment for pinworms should include the administration of a vermicide per os, followed by an enema of infusion of quassia, solution of vinegar or salt. It is best to empty the rectum by an enema of water before injecting either of the above solutions.

LUNG WORMS — STRONGYLUS FILARIA

The treatment for these parasites, with the exceptions of various prophylactic and dietetic measures, is of doubtful value. Theoretically, for the best results, the agents should be volatile, nonirritating, and be injected through the trachea or administered as a spray. Some authorities claim good results with various agents, others deny that any good can be accomplished in the direct application of the drugs or treatment of the worms and lay special stress upon prevention. Oil of turpentine serves well in many cases and is well adapted for this purpose. The following have also been recommended: Phenol in 1 per cent. aqueous solution, doses 20—30 mils (3 4—8); potassium picrate in 1 per cent. solution, dose 3v—℥ij 20.—60.0 mils, according to age and size of the animals. Sodium chloride 1 per cent. sterile solution, may be injected in relatively large doses; iodine in potassium iodide has been recommended by some. Benzine and olive oil, of each equal parts, dose 3 ij—iij for sheep; calves, 3 ij—iv; or, according to Law, benzine is most reliable in 1 dram doses for sheep.

℞ Olei Terebinthinæ.
Olei Olivæ .....āā. 100.0
Creolini 10.0
M. Ft. Sol.
Sig. Sheep, 5 mils; calves, 15 to 20 mils, to be repeated twice.

℞ Creosoti 20.0
Olei Olivæ 100.0
M. Ft. Sol.
Sig. Dose, 5 mils for sheep; 15–20 mils for calves. Repeat in 4 days.

℞ Iodi 2.0
Potassii Iodidi 10.0
Aquæ q. s. .....ad. 100.0
Sig. One-half dram increased gradually up to 5 drams for sheep.

CHAPTER XII

VOLATILE OIL GROUP

ESSENTIAL OILS

This group contains a large number of essential oils which are obtained from plants by distillation, or more rarely by expression, and should be distinguished from the *Fixed or Fatty oils,* which are non-volatile. The volatile oils are found very largely in the fruits, leaves, flowering parts and seeds of plants and are widely scattered throughout the vegetable kingdom. These oils are all extremely odorous and are therefore used to overcome nauseous odors and tastes of medicine, for flavors and in toilet preparations. (They are mainly objectionable to animals.)

The composition of volatile oils is extremely variable. The most common constituents are terpenes and some contain only these, while in a few no terpene has been found. Terpenes may be briefly defined as hydrocarbons of the aromatic series possessing the general formula $(C_5H_8)n$.

Characteristics. Volatile oils are generally clear, colorless fluids, although a few of them may be green from the presence of small quantities of vegetable coloring matter, while others are blue from the presence of a terpene derivative (azulene). Upon long standing they may acquire a yellowish color and an acid reaction from the formation of resins. Most of these oils are light fluids but those of copaiba and cubebs are more viscid. They are freely soluble in alcohol, ether, chloroform and the fixed oils but only slightly soluble in water. Many plants from which these oils are derived also contain other principles, as bitters, but as many of the preparations used in therapeutics are formed from the crude drug and not the oil, it must be remembered that the oil may not be the only active principle of a plant.

Although they differ quite widely in chemical composition, their actions are sufficiently common to be discussed as a group.

External and Local Action. All volatile oils possess antiseptic properties which are probably due in part to their volatility which enables them to penetrate into the protoplasm of the cells and lessen its vitality. They are also closely related to the benzene or benzol series, all of which are antiseptics and protoplasmic poisons. They differ greatly in their germicidal properties and are more toxic to the molds than to bacteria.

When applied to the skin they produce irritation, itching and redness followed by numbness or anesthesia, the irritant effect being increased by their volatility. The oils of cloves and cinnamon are used in dentistry to relieve pain and act as antiseptics. The redness may be due to the penetration of the oil to the cutaneous arterioles or veins, or to reflex action from the irritated terminations of the sensory nerves acting on the vasomotor center.

Digestive System. Volatile oils, in strong solution, are irritant in the mouth. They have a hot burning taste, and if kept in the mouth, cause redness and irritation of the mucous membranes, although a few of them (peppermint) first have a cooling sensation. The sense of smell is at the same time affected by these oils, which are nearly all characterized by distinctive odors. The irritation brings about a reflex secretion of saliva which may be very profuse.

In the stomach they exert the same effect as in the mouth or upon the skin, that is, a mild form of irritation, leading to increased vascularity, more rapid absorption, augmented movement; at the same time they exert their powerful antiseptic action. These actions cause a sense of warmth to the stomach and are often followed by the expulsion of gas and the relief of colic. They are therefore called carminatives. Similar effects are believed to be produced in the intestines because the administration of these oils is often followed by lessened flatulence and distention, and relief in many cases of colic.

Blood. The volatile oils when administered by the mouth produce a leucocytosis especially of the polynuclear variety, but this is observed in congestion of the stomach and intestines from other causes, and does not follow the intravenous or subcutaneous injection of the volatile oils, so that it cannot be considered as a specific action.

Central Nervous System. The volatile oils do not affect the central nervous system except in very large non-medicinal doses. The action is one of stimulation, followed by depression, and is especially marked upon the brain. The effect is thought to be due to the benzene nucleus of the terpenes and varies greatly with the different oils. Generally the stimulation is not a very marked feature; in the case of turpentine it is very transitory and the narcotic action is more pronounced.

Absorption. They are rapidly absorbed.

Excretion. The volatile oils are excreted by the kidneys, lungs and skin. During their excretion by the lungs their odor may be readily recognized in the breath and they exert a mild irritation leading to stimulation of the ciliated epithelium and to reflex coughing and are therefore used as expectorants. At one time it was hoped that they would exert a sufficiently strong antiseptic action

in the lungs to arrest the growth of organisms, but this ideal has not been realized.

The slight amount excreted by the skin acts as a mild irritant producing slight diaphoresis. From the kidneys they are excreted either combined with glycuronic acid or uncombined. They cause here, as elsewhere, a mild antiseptic and irritant action, the latter producing a diuresis. This antiseptic and diuretic action is particularly marked with the oils of cubebs, turpentine and copaiba but may be observed after almost any of them.

Many volatile oils give a peculiar odor to the urine; turpentine and eucalyptus, a peculiar violet-like odor which may be due to some small percentage of an oxidation product as most of the oil is excreted unchanged.

Different oils are used for different purposes in therapeutics, although they all resemble each other in certain respects, and it is therefore convenient to divide them into several therapeutic groups.

1. Volatile Oils Used for Flavors and Carminatives.

Although many volatile oils are used for flavors in human medicine, the choice is largely left to the physician and one will use one oil and another one, another oil. In veterinary medicine they are of little use as flavors because animals as a rule do not care for them. This group of the oils if used at all internally are usually administered for their carminative action. The principal members are:

Oleum Amygdalæ Amaræ	Oil of bitter almonds
Oleum Anisi	Oil of anise
Oleum Aurantii Corticis	Oil of orange peel
Oleum Betulæ Volatile	Oil of sweet birch
Oleum Carui	Oil of caraway
Oleum Caryophylli	Oil of cloves
Oleum Cinnamomi	Oil of cinnamon
Oleum Coriandri	Oil of coriander
Oleum Eucalyptoli	Oil of eucalyptus
Oleum Fœniculi	Oil of fennel
Oleum Gaultheriæ	Oil of wintergreen
Oleum Lavandulæ Florum	Oil of lavender
Oleum Limonis Corticis	Oil of lemon
Oleum Menthæ Piperitæ	Oil of peppermint
Oleum Menthæ Viridis	Oil of spearmint
Oleum Myristicæ	Oil of nutmegs
Oleum Pimentæ	Oil of allspice
Oleum Rosæ	Oil of rose
Oleum Rosmarini	Oil of rosemary
Oleum Sassafras	Oil of sassafras
Oleum Thymi	Oil of thyme
Oleoresin Zingiberis	Oleoresin of ginger

2. Malodorous Volatile Oils.

Some of the volatile oils differ from the others in possessing an

odor which is disagreeable and nauseating to most people, the best known of which are asafœtida and valerian. The oil of valerian is prepared from *Valeriana officialis.* It does not possess a marked odor when freshly prepared but after some time when exposed to the air it assumes an unpleasant penetrating odor. It is interesting to note that while these oils are very disagreeable to most people, asafœtida is used in India as a condiment and valerian was formerly used in England as a perfume.

These two drugs are used in hysteric conditions in human practice and their benefits have been assumed as due to the mental impression produced by their unpleasant odor and taste. Asafœtida is also used as a carminative.

3. Genito-Urinary Stimulants and Disinfectants.

Most important of these are:

Copaiba — Cubebs — Sandalwood — Matigo.

4. For Diuretics. See group of Diuretics.

Juniper	Uva Ursa	Zea
Buchu	Bearberry	Chimaphila

5. Skin Irritants. See irritants and counterirritants.

a. *Turpentine group.*

Turpentine	Tar
Succini	Cajuput
Lavender	Resin
Rosemary	Sabina

b. *Mustard oil group.*

Sinipis Alba Sinipis Nigra.

c. *Cantharidin group.*

Cantharides	Pulsatilla
Euphorbium	Chrysarobinum

Epicarin

6. Used Mainly in Respiratory Diseases.

The volatile oils act as stimulants and antiseptics to the respiratory mucous membranes. They may be applied locally as sprays, inhalations, etc., or given internally as expectorants in chronic bronchitis, exerting their action in the course of their elimination through the lungs.

The most important members of the group are:

Turpentine	Terebene
Terpin hydrate	Pine bark
Tolu	Eucalyptol
Grindelia	Cubebs

7. Toxic and Ecbolic Volatile Oils.

All volatile oils are toxic in large doses. Although it is impossible to exclude systemic effects altogether, the toxic action is due almost entirely to local irritation. The symptoms are gastroenteritis with nephritis as a common sequel. The inflammation of the gastrointestinal tract may spread to the pelvic organs and thereby produce abortion.

Most important are:

Sabine	Hedeoma
Tansy	Apiol
Rue	

8. Volatile Oils Used in Dentistry. There are certain volatile oils used in human dentistry which it seems best to include in this group. They are employed for the twofold purpose of disinfecting the cavity and destroying the nerves of carious teeth. Most important are:

Cloves	Sassafras
Cinnamon	Wintergreen
	(Creosote)

9. Volatile Oils Used as Insecticides. Certain volatile oils or drugs containing them are used to kill or repel certain insects, such as mosquitoes, flies, etc.

Most important are: Insect powder, Persian insect powder (the powdered flowers of the pyrethym species), and Dalmatian powder (the powdered flowers of Chrysanthemum cinerariæfolium), eucalyptus, menthol, cedar, lavender, hellebore, anise.

CHAPTER XIII

DRUGS ACTING UPON THE RESPIRATORY SYSTEM

Respiratory Stimulants are agents which quicken or deepen the respirations through stimulation of the respiratory center. This stimulation may be produced by:

1. Reflex stimulation of the peripheral nerves. (Vapor of ammonia stimulates the nasal branch of the fifth nerve when inhaled and reflexly stimulates the peripheral nerves.) Cold douches act in a similar manner. Artificial respiration besides bringing air in contact with the blood in the lungs also serves this purpose.
2. Direct stimulation of the center through an increase of temperature or venosity of the blood. (External heat, venous blood).
3. Direct through drugs.

Ammonia	Cocaine
Strychnine	Atropine
Caffeine	

Indications. These drugs are of service as respiratory stimulants particularly in pulmonary diseases associated with dyspnœa, as pneumonia, severe bronchitis, emphysema, lowered activity of the respiratory center, exhausting diseases, fatigue and in depression by narcotics.

Ammonia. Ammonia is very serviceable as a quickly acting cardiac and respiratory stimulant in syncope, collapse and other sudden heart failures. It is usually given by inhalation but may be administered intravenously in the proportion of one part of stronger ammonia water to four parts of water.

Strychnine. This drug has a rapid and powerful action with but little danger of undesired effects, but its period of action is relatively short. It is particularly useful in pneumonia and other debilitating diseases, to tide over a period of depression. Some authorities do not recommend it for continuous use, while others advise it throughout the course of serious diseases.

Caffeine. This drug acts more slowly than strychnine but with a more persistent action. General indications for caffeine are given in another place.

Atropine. The action of this drug is not marked although it paralyzes the bronchial muscles, dries up secretions of the bronchi, and is of particular benefit in asthmatic conditions. Atropine is also of considerable service in the second stage of acute diseases of

the respiratory tract as in pneumonia, where it may be combined with strychnine, and serve as a valuable stimulant to respiration, and at the same time prevent effusion and vasomotor and cardiac depression. Atropine is also a valuable vasomotor, cardiac, and respiratory stimulant in cases of poisoning by depressant drugs (ether, chloroform, aconite, eserine, arecoline, pilocarpine).

Respiratory Depressants. These are agents that depress the respiratory center. The most important drugs of this group are:

Opium	Bromides
Chloral	Hyoscine

There are many other drugs that depress the center and produce asphyxia in toxic doses but they are never used in medicine for that purpose. The chief indications for these agents as pulmonary depressants are in diseases of the respiratory tract to allay cough. Most of them have been discussed in other places.

EXPECTORANTS

Expectorants are agents that increase, decrease or modify the secretions of the air passages. The exact manner of their action is unknown although most of them probably act reflexly from an irritant (nauseant) action in the stomach. This has been demonstrated to be the case with ammonium compounds, antimony, ipecac and senega. They may be divided into those that increase and liquefy the secretions, as in dry cough, and those which diminish secretions. They may also be divided as follows:

1. Increasing Secretions.

A.	*Depressant* Nauseant or Sedative	Ipecacuanha Apomorphine Tartar Emetic Senega Lobelia
B.	*Indifferent*	Neutral salts (iodides) Carbonates Pilocarpine
C.	*Stimulant*	Ammonium salts (carbonate and chloride) Digitalis Squill

2. Decreasing Secretions.

Atropine	Aromatic products
Acids	Benzoic acid
Turpentine	Benzoates
Terpine hydrate	Balsams
Essential oils	Tar (Sollmann)

Many authors simply make two divisions of expectorants, classing all except the sedative expectorants as stimulant, and following with the statement that the sedative expectorants increase secretions and the stimulant expectorants check the secretions. The terms *sedative* and *stimulant* as applied to expectorants do not have any reference to their effect upon the secretions but to their action upon the organism as a whole.

The depressant expectorants (sedatives) promote the secretions, render them less viscid, and consequently more easily removed. In addition to this many of them are soothing to the irritated mucous membrane. Most of them will be recognized as emetics, and probably they owe much of their power of increasing secretions to their nauseating properties. They are used in much smaller doses as expectorants than as emetics. In man and those animals which vomit an active emetic will often aid the expulsion of tenaceous mucus (croup in children). Sedative expectorants are indicated in acute bronchitis or in the early stages of other diseases in which there is a hard dry cough, considerable irritation and little or no discharge. In these conditions as in all other active inflammations there is considerable swelling and irritation. The sedative expectorants lower arterial pressure, lessen the blood supply and increase the secretions which have been partly or entirely suspended.

Those classed as stimulant expectorants are largely eliminated through the bronchial mucous membrane and are thought to stimulate the mucosa, increase blood pressure and increase secretions. They are believed to produce this action either by stimulation of the relaxed mucosa or by exerting an antiseptic action upon the secretions. They are indicated in relaxed conditions of the mucosa, as in the second stage of acute diseases of the respiratory system or in chronic bronchitis. The alkalies are especially useful to lessen the viscidity of the mucus, render it more fluid and more easily expelled. Stimulating expectorants are not indicated in acute conditions because to stimulate an already inflamed mucous membrane would do more harm than good.

With the exception of atropine and acids, those classified as diminishing secretion belong to the group of antiseptics and volatile oils and depend upon their elimination through the bronchial mucous membrane for action. Theoretically, at least, they are indicated in cases of purulent discharge from the respiratory tract but whether they act as expectorants or are eliminated in the secretions in sufficient amounts to stimulate the mucous membrane or act as antiseptics has not been proven. Clinically they appear of considerable importance.

Theory of the Treatment of Cough. Cough may be defined as a reflex act involving the respiratory center, resulting in a violent and forceful expulsion of air from the lungs. It consists of

a deep inspiration followed by a forceful expiration with closed glottis. The glottis opens and the air is expelled through the mouth. It has a physiological function in the removal of irritant material from the respiratory passages. It is evident that if these irritants can be removed by coughing, no attempt should be made to check it. On the other hand if these irritants cannot be removed in this manner, or if the cough is excessive or persists long after its cause has ceased to be active, it may do more harm than good. In either of these cases some treatment is necessary.

It is necessary to remember that cough is only a symptom, and if treated as such, no permanent benefit can result unless it is directed against the cause, if this is still active. The source of irritation in the respiratory passages may be free in the lumen of the bronchial tubes, may be in the mucous membrane of the larynx or deeper channels of respiration, or in the lungs.

Since cough is a reflex act it may be treated centrally or peripherally. For the central treatment any drug may be used that depresses the respiratory center. Some of the preparations of opium are the most useful and are preferred in the following order: heroine, codeine, morphine and the crude drug. Chloroform and the bromides are useful but are not so good as the others.

The peripheral treatment is directed at the inflammation and the attendant phenomena and must be modified according to the seat of the inflammation. If accessible to local applications or above the larynx, antiseptics may be applied as a douche or electuary. If below the larynx inhalations of volatile antiseptics are indicated (creolin, creosote, turpentine). These are applied in a manner commonly called steaming. These agents are frequently given orally to produce their effect when excreted by the bronchi and lungs, but are of doubtful value.

The irritation may be diminished by demulcents or anodynes. Although these agents cannot be applied below the larynx, there seems to be some favorable action in more distant irritation. These demulcents (gummy agents) appear to act mechanically by protecting the mucosa from air and bacteria, which are usually the cause of the irritation, although some stimulate the secretion of saliva and tend in this manner to keep the parts moist (acacia, sugar, licorice).

Local anodynes depress the sensory endings of the nerves in the respiratory passages but are of no greater service in the relief of cough than the central depressants and are applied with much more difficulty. Cocaine, atropine or hydrocyanic acid may be used. Hydrocyanic acid is most frequently employed in the form of the official syrup of wild cherry.

Next to the treatment of the cough comes the treatment for changing the character of the secretions. The agents used for this purpose are the expectorants which have been discussed previously.

While it is the general opinion that sedative expectorants should be used in acute bronchitis and stimulant in the chronic or subacute, a combination of the two often works well and it appears that they are frequently prescribed empirically.

Conclusion.

1. The cause of the cough should be treated if known.
2. Antiseptics and astringents are always indicated.
3. The local anodynes have no advantage over the central depressants.
4. The choice of expectorants must be decided in each case. No routine mixture can give good results in all cases.

CHAPTER XIV

DIURETICS

Synonyms. Hydragogues, litholytics, lithothryptics

Diuretics are agents that increase the flow of urine. Diuresis is a copious flow of urine. They may produce this action: 1. By increasing the general arterial pressure; 2. By dilating the vessels of the kidney; 3. By increasing the water content of the blood (salt action); 4. Directly stimulating the renal epithelium; 5. Mechanically.

(1) *General circulatory stimulants.* The representative diuretics of this class are:

Digitalis	Convallaria
Strophanthus	Apocynum

Squill

A portion of the diuretic action of squill is due to its action on the renal epithelium.

(2) *Dilators of the renal vessels.* Local dilatation of the vessels of the kidneys, if not accompanied by a reduction of blood pressure, increases the secretion of urine (vasodilators).

(3) *Salines.* Salts that are readily absorbed from the digestive tract cause diuresis in the following manner: When diffusible substances find their way into the blood, whether directly by injection or absorption from the digestive tract, the flow of urine is increased. Bodies such as sodium chloride, potassium nitrate, potassium acetate, urea, and sugar produce this effect in a typical manner. The primary action of salts, no matter in what concentration or how introduced, is to increase the liquid part of the blood. Isotonic and hypotonic solutions pass directly into the blood but hypertonic first draw liquid from the tissues and assume an isotonic condition, so that the effect becomes the same as if an isotonic solution had been directly injected into the blood. This causes an increased amount of fluid in the blood and a condition of hydremic plethora results.

In hydremic plethora the blood becomes less viscid and arterial pressure slightly raised. These factors, together with the swollen volume of blood, tend to produce a rapid blood flow and as a consequence to form transudation of the excess of fluid through the capillaries. The kidney capillaries are the ones by which the body rids itself of excessive fluid. Therefore if they are functioning

properly there is diuresis, and the excess of water with certain dissolved materials is cast off.

Hydremic plethora and its resultant diuresis may result from the absorption of dropsical fluid under the administration of digitalis. It may also be produced intentionally by the ingestion of water or of solutions of dialyzable substances, so that these are diuretic.

(4) *Direct renal stimulants.* Chief of this group are:

Caffeine	Calomel
Theobromine	Blue mass
Theophylline	Scoparius.

Buchu, uva ursi, turpentine, copaiba, and cubeb also exert a specific action on the renal epithelium, but are mostly used to stimulate the mucosa of the genito-urinary tract and as urinary antiseptics, very rarely as diuretics. They will be considered under the head of stimulants to the genito-urinary tract.

(5) *Mechanical.* These act by flushing out the renal tubules. They include water, milk and organic acids. Their results are produced very much as that of the salines. They increase the amount of fluid in the blood (plethoric hydremia), which raises blood pressure, increases the rate of the blood flow and capillary transudation especially in the kidneys.

There is but little positive knowledge concerning the influence of drugs upon the solids eliminated by the kidneys. The amount of solids may be increased by consuming large amounts of water. This has been shown as due to a flushing out of the waste products and not to any increase in proteid metabolism. It is commonly believed that the alkaline diuretics hasten oxidation in the tissues and consequently nitrogenous elimination but such an action has not been demonstrated. The investigations concerning this action have not been very convincing.

Digitalis, Strophanthus and Caffeine have no pronounced effect upon the solids normally found in the urine, but caffeine occasionally produces slight glycosuria. On the other hand, certain drugs which have no activity as diuretics notably increase the amount of the solids in the urine. For instance, salicylic acid increases the elimination of urea, uric acid, and sulphur compounds. Colchicum probably increases the amount of uric acid, and thyroid extract increases to a great extent the elimination of nitrogen and the phosphates by increasing the destruction of proteids in the tissues.

Uses of Diuretics.

(1) *To remove excrementitious matter from the blood.* They are useful for this purpose when the secretory functions of the kidneys are impaired or suspended, as often in acute febrile diseases,

in passive congestion of the kidneys, and in some forms of Bright's disease.

(2) *To promote absorption and remove liquid from the body in various forms of dropsy.* They are of less advantage in dropsical conditions due to organic diseases of the kidneys than in dropsy due to lowered arterial tension. If dropsy is of renal origin diuretics are not indicated and diaphoretics should be substituted.

(3) *To dilute the urine and lessen irritation of the genito-urinary tract.* For this purpose the alkaline diuretics are useful when the urine is too concentrated or excessively acid. They also relieve the distressing symptoms occasioned by uric acid gravel and uric acid stones, not by exerting any solvent action but by producing a more copious secretion of urine.

(4) *To relieve the heart in cardiac disease.* This is brought about by increased elimination of water from the blood and consequently the work of the heart is lessened on account of the lessened volume of blood.

(5) *To remove poisonous drugs which are normally somewhat eliminated by the kidneys.* This is especially so of the mercuric salts, and some of the vegetable poisons like strychnine. An active diuresis will aid in the elimination of these poisons and should not be neglected.

Digitalis. This drug and its allies have very little if any effect upon the renal epithelium. They produce their diuretic action mainly through their stimulating action upon the heart and blood vessels. Digitalis is particularly of use as a diuretic in different forms of cardiac disease. As the results of its use in serous effusions of an inflammatory nature are in doubt, it is but sparingly indicated as a diuretic in Veterinary Medicine. Convallaria and squill are indicated in about the same class of diseases as digitalis, though possessing more diuretic properties. (See Digitalis and Squill).

Diuretic — Horse.

℞ Potassii Acetatis ..... ℥ ijss
Tincturæ Digitalis ..... ʒ x
Spiritus Ætheris Nitrosi ..... ℥ v
Aquæ q. s. .....ad. ℥ xvj
M. Ft. Sol.
Sig. Give four ounces every four hours.

Caffeine Group. These are the only drugs of any therapeutic importance which cause diuresis through a nonirritant stimulation of the renal cells. Just how these drugs act is not clear. It is generally agreed that they act on the tubules, stimulating them to increased action, but there is another theory, according to which caffeine inhibits the power of the tubules for resorbing water, with a consequent increase in the amount eliminated. Whichever theory

is correct, the important fact for the practitioner is that they do not irritate the kidneys and may therefore be used in nephritis. The theory that these drugs produce a specific dilatation of the vessels of the kidneys is not well taken because it is known that the vessels of every organ dilate when it begins to function actively, and it is impossible to say whether the renal vessels dilate as a cause or effect of the activity. See Caffeine group, p. 126.

* SCOPARIUS

Synonym. Broom

Parts Used. The tops of *Cytisus Scoparius,* a shrub native to Western Asia and Southern Europe and cultivated in other places. It contains two active principles, sparteine, a liquid alkaloid, and scoparin, a neutral principle. Sparteine is the alkaloid most used and is prescribed as the sulphate.

The action is principally upon the heart and kidneys. The crude drug in moderate doses simply serves as a diuretic. Its action upon the heart has been held by some to be similar to digitalis, but this is not so because sparteine slows and weakens the heart instead of strengthening it. The neutral principle, scoparin, is responsible for its diuretic action.

Large doses of scoparius cause vomiting and purging.

Uses. Scoparius alone or with digitalis is occasionally used in cardiac dropsy.

SALINE DIURETICS

The principal members of the saline diuretics are certain salts of potassium, and lithium.

The diuretic potassium salts may be further divided into the vegetable and mineral preparations.

VEGETABLE SALTS OF POTASSIUM

The vegetable salts of potassium are the acetate, citrate and bitartrate. They are incompatible with acids, metallic and alkaloidal salts.

Action. Except in very large doses these salts show no appreciable effect upon the organism except an increase in the secretion of urine. The diuresis is due in large part to the salt action of the drugs and in part to direct action upon the secretory cells of the kidneys. They increase the mineral salts of the urine, the sodium as well as the potassium, and in large doses impart an alkaline reaction to the urine.

Uses. 1. *Acute rheumatism.* Acute rheumatism is often benefited by the administration of these preparations, although the action in this case is not well understood. For this purpose they

* Unofficial.

should be given in large doses every three or four hours until the urine becomes alkaline. They are frequently combined with or given in conjunction with the salicylates for this purpose.

2. *Dysuria.* They are frequently serviceable in dysuria due to excessive acidity of the urine.

3. *Lessen pain* due to calculi on account of their diluent action on the urine.

4. *Sedative expectorants.* For this purpose they serve a useful rôle in the early stages of acute bronchitis, when the secretions are thick and scanty.

POTASSII ACETAS — POTASSIUM ACETATE

This occurs as a white odorless powder or crystalline masses, with a saline taste. It is soluble in 0.4 parts of water and 2 parts of alcohol. The acetate is a very unstable preparation, as it is very deliquescent, on account of which it should not be prescribed in powders and cannot be kept long after the container has been opened. On this account, it is a good plan to make a definite strength solution upon opening a bottle to use when dispensing.

Doses. H. ℥ij—iv; 8.—16. D. grs. x—xxx; 0.6—2.

Action and Uses. This is a pleasant and nonirritating diuretic and is entirely used as such.

POTASSII CITRAS — POTASSIUM CITRATE

This occurs as a white granular powder or transparent prismatic crystals, is deliquescent on exposure to the air, odorless, of a pleasant acidulous taste, soluble in 0.5 part of water, sparingly soluble in alcohol.

Doses. Same as the acetate.

Preparations.

Liquoris Potassii Citratis. D. ℥ss—j; 15.—30.
Potassii Citras Effervescens. Twice those of the acetate.

Action and Uses. The action and uses of this preparation are similar to the acetate and indeed interchangeable with it. The solution is used in mild febrile diseases to promote the secretions from the kidneys and skin.

POTASSII BITARTRAS

Synonym. Cream of Tartar

Occurs as colorless or opaque rhombic crystals or white powder, odorless, of an acid taste, soluble in 200 parts of water, slightly soluble in alcohol.

Doses. Diuretic dose, same as the acetate. Laxative dose for dog, 3j—iv; 4—15.

Action and Uses. This drug differs somewhat in action from the other members of this group, as it is not rapidly absorbed and consequently serves as a mild laxative as well as diuretic. It is one of the ingredients of Rochelle salts. It is used as a mild laxative for small animals and as a mild diuretic for the larger ones.

OTHER DIURETIC SALTS OF POTASSIUM

POTASSIUM NITRAS

Synonyms. Salt Peter, Niter

Potassium nitrate occurs as colorless, transparent, rhombic crystals, or crystalline powder, odorless, of a cooling saline taste, permanent in air, soluble in 3.6 parts of water, slightly soluble in alcohol.

Doses. H. ℥ ij—iv; 8.—15. D. grs. v—xxx; 0.3—2. Repeated twice daily.

Action. It resembles the previous salts except that it is more irritating. As in the case of the vegetable salts of potassium, it increases the urine by its salt action and direct action upon the cells of the kidneys. In large doses, potassium nitrate is not only more irritating than the vegetable salts, but is also more liable to depress the heart and nervous system on account of a relatively greater action of the potassium ion over that of the nitrate ion. It is partly eliminated by the kidneys and saliva unchanged, but a part is believed to undergo a change in the tissues. In toxic doses death is due to gastroenteritis. It is believed by some to possess some alterative properties and is consequently a favorite ingredient of condition or alterative powders.

Externally it is refrigerant.

Uses. 1. *Alterative and febrifuge.* In catarrhal affections and febrile conditions where it is thought to be of benefit by increasing bronchial, cutaneous, and urinary secretions, thus assisting the elimination of waste material. For this purpose it is often combined with small doses of epsom salts and given in the drinking water.

2. *Diuretic.* Here it is probably the most used drug in veterinary practice (in edema of the limbs, lymphangitis, etc.) but should be contraindicated in renal diseases. It possesses no advantage except that of permanency in air, and cheapness, over the less irritating vegetable salts.

3. *Externally and locally.* It serves as a refrigerant in solution in combination with ammonium chloride but has no advantage over ice.

Salts of Lithium. The action of lithium salts is quite similar to the corresponding salts of potassium and, like those of potassium, they increase the secretion of the kidneys and diminish its acidity. They were formerly recommended for gouty conditions and as solvents for uric acid gravel. This use was based on the fact that lithium unites with uric acid and makes a more soluble compound, but the conditions found within the body are so different from those of the chemical laboratory that this action is impossible. Since the alkalies are not excreted as carbonates or in the same form as given, the above results are impossible. There is no reason to believe that they possess any advantage over the corresponding salts of potash or soda, which they resemble closely in action. Lithium carbonate and citrate are official. They occur as white odorless powders, soluble in water, sparingly soluble in alcohol.

Average dose for dogs, grs. viij; 0.5.

Calomel and Blue Mass. The action of these preparations as diuretics is probably due to their irritating action upon the renal epithelium, as in case of all absorbable metals. These are the only metallic preparations used for diuretic action. They are especially useful in cases of cardiac dropsy but are of doubtful value in renal or hepatic dropsies or in cases of serous effusions.

Spiritus Ætheris Nitrosi (Sweet spirits of nitre), Nitre. See Diaphoretics for details of action. This is a pleasant remedy but of feeble diuretic properties. The diuresis probably depends upon dilatation of the blood vessels of the kidneys. Spirits of nitrous ether is also a diaphoretic. Whether it serves as a diuretic or diaphoretic depends upon the conditions under which the animals are kept. If they are kept well covered and warm, it serves as a diaphoretic, otherwise as a diuretic. As a diuretic it seems that it would be of use in those conditions due to increased arterial tension of the kidneys, that is, oliguria due to febrile diseases or active congestion of the kidneys. It is more important for its carminative and diaphoretic actions.

CHAPTER XV

GENITO-URINARY STIMULANTS AND DISINFECTANTS

Those drugs which stimulate the entire genito-urinary tract will be included in this group. They are all eliminated by the kidneys and irritate the cells of the kidneys and more or less increase the amount of urine, but this action is not so important as their stimulant action upon the mucosa of this tract. Many of these agents also possess decided antiseptic properties which are eliminated by the kidneys in sufficient concentration to inhibit the growth of bacteria and prevent the decomposition of urine. Most of these agents are volatile oils or contain a volatile oil to which their action is due. See Volatile Oils, p. 282. In large doses they may cause acute inflammation of the kidneys, bladder and urethra.

Most important members of this group are:

Copaiba	Cantharides
Cubebs	Juniper
Matigo	Oils of
Buchu	Sandalwood
Uva ursa	Turpentine
Urotropin	Erigeron

The combination of the stimulant and antiseptic actions of these drugs makes them especially useful in the treatment of subacute or chronic pyelitis, cystitis and urethritis. They are contraindicated in acute inflammations.

COPAIBA

Synonym. Balsam of Copaiba or Copaiva

Description. This is an oleoresin derived from one or more South American species of *Copaiba.* It occurs as a pale yellow to brownish-yellow, more or less transparent, viscid liquid, having a peculiar aromatic odor and a persistent, bitter, and acrid taste. Insoluble in water; soluble or showing only a slight opalescence in alcohol, and fixed and volatile oils; completely soluble in chloroform and ether.

It contains a volatile oil, a resin and copaivic acid. It is not a true balsam because it does not contain cinnamic or benzoic acid, but is purely and simply an oleoresin.

Doses.

Copaiba. Horses. ʒijss—vj; 10.—25. Cattle. ʒvj—ℨijss; 25.—50. Sheep and Goats, ʒj—ij; 4.—8. Dogs, gr. vij—ʒss; 0.5—2. Cats, grs. iij—xv; 0.25—1.

Oleum Copaïba is a volatile oil distilled from copaiba.

Doses. One-half those of copaiba.

Action. In small doses it is a stimulant to the mucous membranes generally. Since it is eliminated by the mucosa of the bronchi and kidneys it serves as a diuretic and expectorant. It is also an antiseptic and renders the urine and bronchial secretions antiseptic. Large doses are irritant, causing abdominal pain, gastro-enteritis, nephritis, and frequent micturation.

Uses. 1. In chronic discharges from the genito-urinary tract, pyelitis, cystitis, urethritis, but it should not be given until the most acute symptoms have subsided.

2. In subacute or chronic bronchitis with excessive purulent discharge it often produces good results, but is generally inferior to guaiacol or some of its preparations for this purpose.

Administration. All preparations of copaiba are very disagreeable and should therefore be administered in capsule or an emulsion.

CUBEBA

Synonyms. Cubeb, Cubebs, Cubebo

Cubeb is the dried unripe but fully grown fruit of *Piper Cubeba,* a perennial climbing vine of Borneo and vicinity. It contains a volatile oil, a resin and cubebic acid.

Doses and Preparations.

Powdered drug. H. ʒv—ℨij; 20.—50. gm. D. gr. xv—lxxv; 1.—5. gm.

Oleum Cubebæ. H. and D. one-half of the above.

Action and Uses. With the exception of being less irritant than copaiba, cubebs closely resemble that drug in action and uses. These drugs are frequently prescribed in combination and often give better results than when either is used alone. As in case of copaiba, cubebs should be administered in capsules or an emulsion.

OLEUM — SANTALI

Synonyms. Oil of Santal or Sandalwood

This is a volatile oil distilled from the wood of *Santalum album,* a tree which grows in Southern India. It is used almost entirely for small animals, the dose being for dogs, ♏ v—xx.

The action and uses are similar to those of the previous two drugs.

* MATICO

Matico is the leaves of *Piper Angustifolium,* a shrub of Mexico and South America. It contains a volatile oil, resin, tannic acid and artanthic acid.

Official Preparations and Doses.

Fluidextractum Matico. D. ♏ xxx—lx; 2.—4.
Tinctura Matico. D. ʒss—ij; 2.—8.

This drug is very little used in medicine, although it might be used in the same conditions as the preceding drugs. Besides this action, the leaves seem to favor coagulation and to arrest minor hemorrhages, due no doubt to the presence of tannic acid.

* TEREBINTHINA

Synonym. Turpentine

This is a concrete oleoresin obtained from *Pinus palustris* and from other species of pinus (pine). It occurs in yellowish opaque masses, brittle in the cold; lighter internally, sticky and more or less glossy. Taste and odor of turpentine. It is composed of a volatile oil, oleum terebinthinæ (oil of turpentine) and a resin (rosin) and is decomposed into these when distilled.

OLEUM TEREBINTHINAE

Synonyms. Oil of Turpentine, Spirits of Turpentine

Oleum Terebinthinæ occurs as a thin, colorless liquid, having a characteristic odor and taste, soluble in 3 parts of alcohol, insoluble in water.

Preparations and Doses.

Oleum Terebinthinæ. Carminative. H. and C. ʒj—ij; 30.—60. Sh. and Cow. 3j—iv; 4.—15. D. ♏ x—xxx; 6.—2.
Anthelmintic. H. and C. ʒij—iv; 60—120. D. ʒss—iv; 2.—5.
Diuretic. H. and C. ʒij—vj; 8.—24.

OLEUM TEREBINTHINAE RECTIFICATUM

This is prepared by redistilling oil of turpentine over a solution of sodium hydroxide, and should be prescribed for most cases of internal medication.

Dose. Same as above.
Emulsum Olei Terebinthinæ, 15 per cent.
Linimentum Terebinthinæ, 350 to 650 of resin cerate.

* Unofficial.

Externally. Turpentine is an irritant to the skin, producing all the stages of inflammation, from redness to pustule formation, according to strength of the preparation used and method of application. It is extremely irritant to horses and dogs. Horses show a considerable amount of pain after its application and the resultant sore is a slow healing one. It is also an antiseptic and deodorant of considerable value.

Internally. In moderate doses turpentine produces a sense of warmth to the stomach and serves as a carminative and antiseptic. It is also a fairly efficient anthelmintic, especially against round worms, but is not so active as a tænicide.

It reflexly stimulates the heart and respiration, probably by irritation of the mucosa of the stomach. It is rapidly absorbed and eliminated, escaping from the body largely by way of the urinary and respiratory tracts, causing diuresis, stimulating the mucosa of the urinary tract and giving a peculiar odor to the urine (violet odor). In overdoses or toxic doses turpentine causes abdominal pain, nausea, purging in some cases, rapid weak pulse, slowed respirations, and muscular weakness. There is marked irritation of the kidneys and this may be accompanied by strangury, suppression of the urine or hematuria. The action is that of volatile oils, for which see p. 282.

Therapeutics.

1. *Counterirritant.* (a) It is valuable as a rubifacient in various forms of inflammation, such as bronchitis, pleuritis, pneumonia, gastritis and enteritis. In these cases probably the best method of application is the turpentine stupe. This is prepared by sprinkling freely with the oil a blanket or woolen cloth which has been previously wrung out of hot water. This is then applied to the chest, or other part of the body, covered with some material to hold the heat, and left for half an hour or longer, according to the results desired.

(b) Liniments containing turpentine are useful to relieve inflammation and soreness in muscular rheumatism, sprains, etc.

2. *Carminative.* It is very useful to relieve acute gastric tympany and flatulent colic in the horse and tympanities of the rumen in cattle. For this purpose it is usually combined with some preparation of ammonia and administered with linseed oil or may be given in capsule. In these cases it causes the expulsion of the gas already formed and prevents fermentation to which the condition is due.

3. *Hemostatic.* It has been recommended by some as a hemostatic for internal hemorrhages, although the method of action is unknown. It is inferior to other agents for this action.

4. *Purpura Hemorrhagica.* The use of turpentine in this dis-

ease of the horse is of long standing. Good results often follow its use, although its action cannot be explained satisfactorily. It is usually combined with tincture of the chloride of iron.

5. *Anthelmintic.* Especially for round worms of horses, dogs and swine. Also as an intratracheal injection for lung worms of calves and lambs. Not very effective against tape worms. It is usually given in oil.

6. *Antiseptic expectorant.* In cases of subacute or chronic bronchitis with excessive purulent secretion, but it is thought to be inferior to some form of terebene. It is often used for its local action upon the respiratory tract in various respiratory diseases. For this purpose it may be added to hot water and the animal allowed or compelled to inhale the vapor (steaming).

7. *Stimulant to genito-urinary tract.* In same diseases as mentioned under the previous drugs.

8. *Phosphorus poisoning.* Turpentine on standing is supposed to be ozonized and is therefore useful to oxidize phosphorus. This action is very much in doubt in case of the present commercial turpentine.

Contraindications. Turpentine should not be administered when there is nephritis, congestion of the kidneys or acute inflammation of the gastrointestinal tract.

Administration. It should be administered as an emulsion, in oil, mucilage, or in capsule.

Prescriptions.

White thick liniment.

℞ Pulveris Saponis ..... ℥ ij
Olei Terebinthinæ ..... ℥ xxiv
Aquæ Ammoniæ Fortioris ..... ℥ ij
Ammonii Chloridi ..... ℥ iv
Aquæ q. s. .....ad. Cong. j

Mix the soap and ammonia water and ammonium chloride in one-half gallon of water, shake well and add the turpentine and enough water to make one gallon.

Tympany. Horse or cow.

℞ Olei Terebinthinæ ..... ℥ iv–viij
Spiritus Ammonæ Aromatici..... ℥ j
Olei Lini ..... ℥ xxiv
M. Ft. Haustus.
Sig. Give at once.

Dog. Fetid Bronchitis.

℞ Olei Terebinthinæ ..... ℥ ijss
Acaciæ ..... ℥ v
Aquæ Destillatæ ..... ℥ x
Misce et fiat emulsum.
Sig. Teaspoonful three times daily.

Worms. Horse.

℞ Olei Terebinthinæ ..... ℥ ij
Olei Lini .....O. j
M. Give at one dose after feeding on soft food for two days.

Purpura Hemorrhagica. Horse.

℞ Olei Terebinthinæ ..... ℥ j
Tr. Ferri Chloridi ..... ℥ ss
Acaciæ ..... ℥ ss
Three times daily.

Colic. Horse.

℞ Olei Terebinthinæ ..... ℥ ij
Spiritus Camphoræ ..... ℥ ij
Ætheris ..... ℥ jss
Misce et fiat solutio.
Sig. Give at one dose. Repeat in 2 hours if necessary.

RESINA

Synonyms. Resin, Rosin

This is a hard, transparent amber colored mass.

Preparations.

Ceratum Resinæ (resin 35 parts, yellow wax 15 parts, lard 50 parts).

**Ceratum Resinæ Comp.* Resin 22.5 parts, yellow wax 22.5 parts, suet 30 parts, turpentine 11.5 parts, linseed oil 13.5 parts.

Emplastrum Resinæ. Resin 14 parts, lead plaster 80 parts, yellow wax 6 parts.

Internally resin is a feeble diuretic and astringent. It is antiseptic and astringent when applied locally.

Uses. It is a favorite ingredient of many diuretic balls and powders. Externally the two cerates are used as stimulants to indolent wounds.

TEREBENUM (TEREBENE)

This is a liquid consisting of dipentene and other hydrocarbons obtained by the action of concentrated sulphuric acid on the oil of turpentine and subsequent rectification with steam. It should be kept in a well-stoppered bottle in a cool place protected from light. Terebene is a colorless thin liquid having a rather agreeable thyme-like odor, and an aromatic, terebinthinate taste.

Dose. H. 3ij—vj; 8.—24. D. ♏ v—xv; .3—1.

Action and Uses. This drug resembles the action of oil of turpentine, but it is more diffusible and less irritating to the kidneys.

It may be used in any condition where turpentine would be indicated, but is to be preferred in chronic respiratory diseases.

For Chronic Bronchitis.

℞ Terebeni.
Eucalyptolis .....āā. ℥ ij
Syrupi q. s. .....ad. O. j
M. Ft. Sol.
Sig. One ounce every two hours for a horse; 15–30 drops for a dog.

TERPINI HYDRAS — TERPINE HYDRATE

Terpine hydrate is usually manufactured by treating an alcoholic solution of the oil of turpentine with nitric acid. The mixture is placed in an evaporating dish and allowed to stand three or four days, when the crystals of terpine hydrate appear. The liquid is drained off, the crystals are then dried between sheets of filter paper. They are then reprecipitated to purify them.

Doses. H. ℥ss—j; 2.0—4.0. D. gr. v—xx; 0.3—1.3.

Action and Uses. The action and uses are similar to those of the oil of turpentine. It is used in chronic affections of the respiratory tract. Combined with heroin it is serviceable in irritable coughs.

For Cough. Dog.

℞ Heroinæ	0.1	gm.	gr. jss
Terpini Hydratis ...	1.0	gm.	gr. xvj
Alcoholis	45.	mils	℥ jss
Syrupi Pruni Virginianæ q. s...ad.	100.	gm.	℥ iij

M. Ft. Sol.
Sig. Teaspoonful every 3 hours.

*Sanitas. This is prepared by the oxidation of the oil of turpentine. It is said to contain a soluble camphor, camphoric acid, thymol and hydrogen peroxide. It is used as a disinfectant, deodorant and antiseptic.

* JUNIPERUS — JUNIPER

Synonyms. Juniper, Juniper Berries, Fructus Juniperis.

Juniper was official up to revision of 1880 as the fruit of *Juniperus communis,* an evergreen shrub of Northern Europe, Asia, and North America. It contains a volatile oil, a resin and a noncrystalline principle, juniperin.

Preparations and Doses.

Juniperus. H. ℥j—ij; 30—60. D. gr. xv—lx; 1—4.

Oleum Juniperi. This is a volatile oil distilled from the above drug. H. and C. ℥j—iv; 4.—8. D. ♏ij—x; 0.13—0.6.

* Unofficial.

Spiritus Juniperi. 5 per cent. of oil of Juniper.

Spiritus Juniperi Compositus. This is a substitute for Holland Gin. It is a solution of the oils of juniper, caraway and fennel in 70 per cent. alcohol. H. and C. ℥ij—iv; 60.—120. D. ʒj—iv; 4.—15.

Action and Uses. Juniper is quite similar in action to turpentine. It is a diuretic, expectorant, carminative and stomachic and is probably more diuretic than most of the members of this group. The berries are added to gin to give its characteristic odor.

Juniper is not frequently used in veterinary medicine and when used is almost always prescribed as a diuretic or stimulating expectorant. For the former purpose it may be used to increase the urine in passive congestion of the kidneys, resulting from chronic heart disease. In subacute or chronic diseases of the genito-urinary tract it is not generally regarded as so serviceable as buchu, copaiba, or oil of sandalwood. It is undoubtedly most used as an expectorant in chronic respiratory diseases.

Bronchial Catarrh. Cow.

℞ Juniperis ..... ℥ viij
Sodii Sulphatis ..... ℥ xvj
Ammonii Chloridi ..... ℥ ij
Misce et fiat pulvis.
Sig. One tablespoonful on each feed.

Catarrh of the Bladder. Dog.

℞ Olei Juniperi ..... ʒ ijss
Alcoholis ..... ʒ v
Misce et fiat solutio.
Sig. 10 drops every three hours.

* OLEUM ERIGERONTIS. OIL OF ERIGERON

Synonym. Fleabane

This is a volatile oil obtained from the fresh flowering herb of *Erigeron Canadensis,* an annual plant of North America. The oil is a pale yellow liquid, with persistent aromatic odor and taste. It resembles turpentine in action, but is less powerful. It is little used in veterinary medicine. It has some reputation as a hemostatic in slight, persistent, internal hemorrhages.

BUCHU

Parts Used. The leaves of *Barosma betulini,* a plant growing in Southern Africa. It contains a volatile oil from which Barosma camphor is obtained, a glucoside and a bitter.

* Unofficial.

Preparations and Doses.

Fluidextractum Buchu. H. ℥j—ij; 30.—60. D. ♏ v—xxx; 0.3—2.0.

Powdered leaves, same as fluidextract.

Action and Uses. Buchu is a feeble diuretic and stimulant to the genito-urinary tract. The volatile oil is largely eliminated by the kidneys, causing diuresis, and imparting to the urine a peculiar odor and some antiseptic properties. Overdoses produce about the same symptoms as overdoses of other volatile oils.

Buchu is useful in the less severe cases of subacute and chronic cystitis and is particularly valuable in chronic irritability of the bladder shown by a frequent desire to urinate. It is well to prescribe it with an alkali.

Irritable Bladder. Dog.

℞ Fluidextracti Buchu ..... ʒ vj
Potassii Citratis ..... ʒ iv
Spiritus Ætheris Nitrosi..... ℥ j
Aquæ q. s. .....ad. ʒ vj
Misce et fiat solutio.
Sig. Teaspoon or tablespoonful, according to size of animal, every three hours.

UVA URSI

Synonym. Bearberry

Parts Used. The leaves of *Arctostaphylos Uva-ursi,* an evergreen shrub, native to northern continents. It contains two active principles (glucosides), arbutin and ericolin, besides tannic acid and an inert resin (urson). Its action is due largely to its glucoside arbutin.

Dose.

Fluidextracti Uvæ Ursi. H. ℥ss—ij; 15.—60. D. ℥ss—iv; 2.0—8.0.

Arbutin. H. not used. D. grs. ij—iij; 0.13—0.3.

Uva Ursi has the typical action of other members of the group, diuretic, stimulant to genito-urinary tract, and renders the urine more or less antiseptic. It is eliminated partly unchanged and partly as hydroquinon. Both the crude drug and arbutin render the urine dark green, probably on account of the oxidation of the hydroquinon. As it contains tannic acid it is an astringent and for the same reason is incompatible with the spirits of nitrous ether.

Uses. It may be employed in the same conditions for which buchu is recommended, but is generally considered inferior to it.

* CHIMAPHILA

Synonym. Pipissena

Chimaphila is the leaves of *Chimaphila umbellata,* a perennial of Northern America, Europe and Asia. It contains arbutin, ericolin, urson and a neutral principle, chimaphilin.

Doses.

Fluidextractum Chimaphilæ. D. ℥ss—j; 2.0—4.0.

Since the constituents are so similar to those of buchu the action and uses are practically identical with it.

* PAREIRA

Synonym. Pareira Brava

The roots of *Chondrodendron tomentosum,* a climbing tree growing in Brazil and Peru. They contain as an active principle an alkaloid, buxin and tannic acid. The action and uses are similar to buchu.

Cantharis, Cantharides. Since cantharides has a more typical and important action it will be studied in detail in another group. In moderate doses it is a stimulant to the genito-urinary tract, but in large doses is a severe and dangerous irritant. Toxic doses or even large ones are irritant to the gastrointestinal tract, as well as to the genito-urinary tract. The most important and typical results of large doses are: gastro-enteritis, with pain, nausea, vomiting or purging. Upon the genito-urinary tract it may cause nephritis, dysuria, frequent micturation, hematuria and albuminuria. It has been recommended as a stimulant to the genito-urinary tract but is rarely used for this purpose, except as an aphrodisiac.

* ZEA

Synonym. Cornsilk

Zea or cornsilk is the stiles and stigmas of *Zea mays* (Indian corn). Its activity is due to a resin and maizenic acid.

Fluidextractum Zeæ. D. ℥ss—ij; 2.—8.
Decoctum Zeæ, 5 per cent. D. ℥j—ij; 30.—60.

Cornsilk really belongs to the group of diuretics. It is a feeble diuretic and sedative to the genito-urinary mucous membrane. It may be of some use in acute cystitis and various forms of nervous irritibility of the bladder, but is of little value in veterinary medicine.

* Unofficial.

SEDATIVES TO THE GENITO-URINARY TRACT

There are so few remedies which exert any direct sedative action upon the genito-urinary tract that a separate group will not be made. Belladonna and hyoscyamus are the most important direct sedatives to the tract, and may be used for this action in acute inflammatory conditions of the bladder or urethra. See Belladonna group for details. Besides these drugs, many others serve as indirect sedatives to this tract, not by exerting any direct sedative action but by removing the cause of the irritation. In this manner, urotropin, boric acid, copaiba, etc., by imparting an antiseptic action to the urine help in overcoming infection of the tract and in this way relieve inflammation. The alkaline diuretics may relieve severe conditions due to acidity of the urine.

CHAPTER XVI

DRUGS ACTING UPON THE GENITAL ORGANS

Emmenagogues are agents which act upon the nongravid uterus and increase or promote the menstrual flow (in women) or which favor the occurrence of estrum (heat) in the domestic animals.

Ecbolics or occytoxics are those agents which stimulate the gravid uterus to the expulsion of the fetus. They are also termed abortifacients.

Emmenagogues may act (1) indirectly by removing the cause of the suppression or by improving the general condition of the animal or (2) by directly stimulating the uterus.

The indirect include such drugs as

Salts of Iron	Strychnine
Arsenic	Cod Liver Oil
Copper	Purgatives

Tonics in General

The direct emmenagogues include those agents which are irritant and toxic, and since they may produce abortion in pregnant animals they are also ecbolic and will be discussed under that head.

Uses. The emmenagogues are not much employed in veterinary medicine as such. The indirect emmenagogues may be occasionally useful in cases where there is some constitutional weakness, such as anemia, obesity, etc. In addition to the general improvement of nutrition, iron often serves well, especially if the cause is anemia. *Emmenagogues* are rarely needed in veterinary practice because failure to come in heat in animals is usually due to some lesion in the genital tract, which cannot be overcome by the administration of medicine.

Ecbolics or Occytoxics. With few exceptions, the greatest importance of this group of drugs to veterinary medicine, is that they tend to cause abortion and should therefore be used cautiously in pregnant animals.

The ecbolics or occytoxics may produce their effect by direct action on the muscles of the uterus (ergot group), or indirectly by action upon a center supposed to be located in the spinal cord. This however is purely theoretical. The chief ecbolics are

Ergot	
Corn Smut	Cotton Root Bark
Quinine	Hydrastis

To the above group must be added all other drugs which congest the abdominal organs:

1. *Irritant and toxic volatile oils.*

Apiol	Myrrh	Thyme
Senechio	Tansy	Turpentine
Pennyroyal	Savine	Rue

2. *All other intestinal irritants.* Potassium Permanganate, Cantharides, Quinine, Digitalis, Oxalic acid.

3. Drastic purgatives.

In regard to the above statements it should be noted that practically all of the drugs mentioned, in large doses, produce severe if not fatal gastroenteritis. The hyperemia resulting from this inflammation does not remain localized in the intestines but extends to the other abdominal organs, which although not directly influenced by the drugs, take part in the inflammation. One of the most important and first organs to become affected is the uterus. This accounts for the use of irritants as ecbolics. Many organic irritants, volatile oils, have considerable reputation as ecbolics, but this action is only secondary to the inflammation of the digestive tract which in many cases may be severe enough to cause death without producing abortion.

General Indications. 1. As oxytoxics during labor to stimulate a tardy expulsion of the fetus when the cause of dystokia is simply due to inertia of the uterus.

2. After parturition to check post partum hemorrhage by causing contraction of the uterus and thus diminishing the size of the bleeding capillaries. They are of but little if any use in veterinary medicine for this purpose.

3. After parturition to contract the uterus and so lessen liability of prolapse of the organ.

ERGOTA — ERGOT

Synonyms. Ergot of Rye, Secale Cornutum, Spurred Rye

Ergot is the sclerotium of a parasitic fungus, *Claviceps purpurea,* which replaces the head of the common rye. This sclerotium represents a period of development of the fungus which is between the *mycelium* and the spore bearing *thallus.* It is obtained largely from Russia, Germany and Spain. It occurs as hornshaped pieces, about ½ to 1 inch long, and ⅛ inch thick and has a peculiar oily taste.

Although a vast amount of study of the composition of ergot has been made and it has been claimed on many occasions that the active principles have been discovered, experience has shown that the supposed active principle represented at most only a part of the activity of the drug.

It is certain, however, that ergot contains several active principles, some of them present in minute quantities but having extraordinary activity, and there are at least four constituents which should be mentioned. These are *ergotoxine* and *ergotinine,* two alkaloids which are closely related, and two substances, *tyramin* and *histamin,* commonly considered as putrefactive principles, because they are present in putrefying meat.

Ergotoxine, an extremely active alkaloid, is the hydrate of ergotinine which is inactive but is probably changed into ergotoxine under some conditions which are not understood. Ergotinine was discovered many years ago but ergotoxine was only recently isolated in pure form and represents the active portion of various substances which have been isolated in different degrees of purity by different investigators and given various names.

Tyramin resembles epinephrine in its chemical composition and physiological actions. It is formed from tyrosin during putrefaction on account of which it received its name. It probably constitutes the chief constituent of aqueous preparations of ergot, as ergotoxine is insoluble in water. Tyramin causes active contractions of the pregnant uterus.

Histamin causes contraction of the uterus, constriction of some vessels and dilatation of others, but is said to be present in ergot in amounts too small to influence the uterine contraction of ergot to any extent. According to some, however, its action is so vigorous that it should not be ignored although it may escape isolation in amounts that can be utilized profitably. It may be prepared synthetically. Ergot also contains saponin which is of no importance unless the drug is to be used intravenously.

It is thought that all the pharmaceutical preparations which have decided therapeutic activity contain either ergotoxine, tyramin or both. The following table will show the relationship between some of the older preparations, and the active principles known to exist as given by Barger and Dale:

Ecbolin and Ergotin (*Wenzell*): Mixture of alkaloids containing cholin (Meulenhoff).

Sphacelinic acid (*Kobert*): Inactive resin with adherent alkaloid.

Cornutin (*Kobert*): An alkaloidal resin probably containing some ergotoxine, and also some other active substances which may be a decomposition product of ergotoxine.

Cornutin (*Keller*): Impure mixture of ergotinine with ergotoxine.

Chrysotoxin (*Jacobi*): Inactive yellow coloring matter with a small proportion of adherent alkaloid.

Secalintoxin (*Jacobi*): Mixture of ergotoxine and ergotinine.

Spaeclotoxin (*Jacobi*): Impure ergotoxine.

Hydroergotinin (*Kraft*): Recent synonym for ergotoxine.

Preparations and Doses.

Ergot. Horses ℥ ijss—vj; 10.—25. Cattle ℥ v—xij; 25.—50. Sheep, goats and swine ℥ ss—j; 2.—5. Dogs grs. vij—xxx; 0.5—2.0. Cats grs. iij—xv; 0.2—1. Fowls, retention of eggs, grs. iij—vij; 0.2—0.5.

Fluidextract: Same as for ergot.

Extract: 1/7—1/8 as much as of the crude drug.

* *Wine:* 4 times as much as of the fluidextract.

All these preparations of ergot deteriorate, but the fluidextract is as reliable as any and in many cases better than many of the proprietaries on the market.

Dose of ergotoxine phosphate, dog, gr. 1/50; 0.002; tyramin, gr. 1/2; 0.03. Hypodermically. They are not irritating.

Standardization. Since ergot varies greatly in its activity and deteriorates somewhat quickly, some means of standardization is necessary. There is, as yet, no chemic assay which has proved satisfactory and the physiologic method is necessary. There are three methods of physiologic assay: the blood pressure method, the uterine method and the cock's comb method. The first method is not good because the pressure effect is no indication of its action upon the uterus. The uterine method is satisfactory, but it is too expensive. The cock's comb method is based upon the development of a purple hue in the comb of a rooster from an injection of ergot. The standard is 0.75 mil of the fluidextract per kilo, (= 1.87 mg. of ergotoxine phosphate).

Deterioration. Ergot deteriorates rapidly unless kept from the air, and several investigators agree that preparations are useless if more than a year old. This, however, is not found to be the case in clinical experience and corresponds very closely to later researches which show that there is a gradual deterioration after two years so that those preparations which were five years old required 1.75 mil to produce as much reaction as 0.75 mil of a potent extract.

Action. The active principles of ergot stimulate those sympathetic nerve endings which have motor functions and ergotoxine in large doses paralyzes them, while the endings of those fibers which are concerned with inhibition are not affected by it. Ergot acts

* Unofficial.

upon a whole group of nerve endings which have similar functions. This results in constriction of the blood vessels, with a rise in blood pressure, and in contraction of those plain muscles which contract in response to stimulation of the sympathetic. Ergotoxine resembles the action of adrenaline in its effect upon the motor nerve endings or their myoneural junctions of the sympathetic, but differs from it in not stimulating those structures concerned in inhibition.

Local Action. Ergot is irritant to mucous membranes and raw surfaces. It does not constrict the vessels of the mucous membrane, but when injected subcutaneously there may be a constriction of the arteries at the point of injection. Local gangrene sometimes follows its use.

Digestive Tract. Preparations of ergot are irritant locally and may cause nausea and vomiting, or, in poisonous doses, a violent gastroenteritis. The alkaloids are not irritant. Therapeutic doses of ergot decrease intestinal peristalsis by stimulating the ends of the splanchnic (inhibitory) nerves, while very large doses cause increased peristalsis by paralyzing these same nerve endings. This action is not seen in the therapeutic use of the drug.

Circulatory System. Ergotoxine or tyramin injected intravenously will cause a marked rise in blood pressure very similar to that of adrenaline, but the rise is slower and its duration three or four times as long; furthermore it may be obtained from oral or subcutaneous administration. The constriction of the arterioles at the site of injection is not so great as that from adrenaline but is more persistent and has resulted in gangrene in some instances. The action is peripheral and appears to be exerted upon the myoneural junctions of the vasoconstrictor nerves.

The isolated heart may be increased in rate and strength but in intact animals may be slowed on account of increased blood pressure.

According to several writers the effect of tyramin in human blood pressure is not marked when given per os and fairly large doses were required to increase blood pressure when given hypodermically. When obtained it resembles a retarded adrenaline action.

Although the active principles of ergot produce constant results, the effect of the preparations of the crude drug are not certain. It may produce either a striking rise or fall in pressure. The fall is thought to be due to the presence of saponin bodies. It is not practical, at least, to administer ergot in therapeutics for increased pressure but its alkaloids may be used in emergency.

Gangrene follows chronic poisoning and is probably due to the prolonged powerful constriction of the arterioles which almost completely arrests the circulation.

Chronic poisoning (ergotism) is easily produced in pigs and

fowls, and is quite common in cattle fed upon smutted grain. It is difficult to produce in dogs and cats.

Respiratory System. Ergotoxine depresses the respiratory center and renders the breathing slow and shallow.

Nervous System. Unless long continued, moderate doses have no appreciable effect upon this system. But if long continued there may be anesthesia, paresthesia, convulsions, tonic contractions of the limbs and ataxia.

Uterus. Ergot produces contraction of the uterus in pregnant animals. In the early stages of pregnancy this increase may be seen in the strengthening of the normal intermittent contractions which take place at this time; and there is a popular belief among the laity and in the professions that ergot is abortifacient in the early period of pregnancy. Experiments with animals have not shown it to possess this power to any marked degree.

During labor moderate doses tend to increase the normal contractions and lead to a normal expulsion of the fetus with little if any danger to it or the mother. For this reason ergot is often used in labor when the contractions are weak and irregular and the fetus in normal position. Large doses cause a continuous or tetanic contraction of the uterus, which makes the drug useful after labor to hasten postpartum uterine contraction. These large doses should not be administered until the uterus is empty because the continuous contractions might simply contract the uterus upon its contents without expelling them. Furthermore the uterus might be ruptured or the offspring asphyxiated by continuous pressure on the cord.

The action of ergot upon the uterus is partly from central origin but is largely due to stimulation of the nerve endings in the uterine muscle.

Ergot has some action in checking hemorrhage from the uterus but this is due to its power to contract the uterus and to little if any action upon the uterine arteries.

Toxicology. Acute fatal ergot poisoning is not common in man or animals. Large doses have been given without producing fatal effects and without producing abortion. The more common poisoning is of the chronic type (Ergotism) and runs a protracted course. It is caused by taking large amounts of the drug at one dose or most frequently by taking repeated doses of ergot mixed in the food, or by eating smutty corn.

Chronic poisoning by ergot used to appear quite frequently endemically in man on account of the presence of ergot in flour, especially where large amounts of rye were consumed. The ergot grows upon the rye and unless destroyed before harvest it becomes mixed with the grain when threshing, and is finally ground up in flour. The populace in wide areas have been poisoned in this manner

and stock suffer in a similar manner. The last outbreak of considerable size in this country was in New York in 1825. Since the cause of the trouble has become known, the outbreaks have not been so frequent but still occur in some places, particularly in Russia.

Ergotism may take so many different forms that they appear to have little or no relation to each other. This difference has been explained by the fact that the action of the active principles of ergot are so different. The two common types are the gangrenous and the nervous, both results of the action of the drug upon the circulation. Of animals affected, horses, sheep, pigs and cattle appear most susceptible, the dog and rabbit less so.

Gangrenous. The gangrene affects those parts poorest in blood supply, the extremities, tail, and ears. The lesions may vary from simple sores around the top of the hoof, in the interdigital space, upon the teats, etc., to loosening of the sole or wall or sloughing of an entire limb. If the entire limb sloughs there is usually a circular line of demarcation between the healthy and gangrenous area. In man the sloughing usually appears first upon the fingers and toes. The gangrene may be dry or moist and does not differ essentially from other gangrene. The small arteries of the part contain hyaline plugs as in other cases of gangrene. The theory as to the cause of the gangrene has been discussed previously.

Nervous form. The nervous or spasmodic form is ushered in by anesthesia or hyperesthesia of the skin. Both may exist in different localities of the body at the same time. These conditions begin at the extremities and spread toward the body. There are also some disturbances of sensation in the digestive tract. There may be a craving for food and a lack of appetite at the same time, digestion is impaired, nausea, vomiting and diarrhea are common. The involvement of the central sensory apparatus is shown by the loss of special senses. The motor area later begins to be affected, causing twitching, tremors, ataxia, convulsions and painful contractions of the muscles and delirium. Animals frequetly die in convulsions.

Treatment: This is purely symptomatic.

Administration. A good tested preparation should always be used. The fluid extract is a serviceable preparation and may be given per os, or injected intramuscularly. On account of the constriction of the blood vessels and the local irritant action it should not be given subcutaneously.

Therapeutics.

1. Labor. Ergot may be used in labor, in small doses, to hasten the expulsion of the fetus, when the delay in birth is due to uterine inertia and not to mechanical obstruction. For this purpose the use of ergot is almost entirely confined to the practice of small animals. To use ergot in full doses, in dystokia due to some mechanical ob-

struction, such as abnormal presentation, rigid os, or contracted pelvis, is usually dangerous because the strong tetanic contractions of the uterus may rupture that organ or may asphyxiate the young by increased, prolonged pressure upon the cord.

2. After parturition, to contract the uterus and so lessen the danger of prolapse of the organ.

3. To check internal hemorrhages, ergot has some reputation as a hemostatic agent but there is a difference of opinion in regard to the results from its use.

4. After parturition to constrict the uterus and so lessen the liability of hemorrhage.

5. The active principles may be used in emergency to revive blood-pressure in shock and collapse.

* GOSSYPII CORTEX

Synonym. Cotton Root Bark

This is the bark of the root of the ordinary cotton plant. It has had some reputation as an abortifacient largely based on its use among the slaves of the south for this purpose.

Ustilago Maydis (*Corn Smut*) is a smut growing on the stems and tassels of Indian corn, Zea Mays.

Action and Uses. Both of these drugs have some reputation as abortifacients and are said by some authorities to have an ergot-like action. Their uses are the same as given for ergot but they are probably inferior to that drug.

Pituitary Body. Solution of the pituitary body is an excellent agent in dystokia due to inertia of the uterus, especially in small animals and swine. It is administered subcutaneously. See p. 100.

ECBOLIC VOLATILE OILS

OLEORESINA PETROSELINI

Synonym. Liquid Apiol

This is an oleoresin obtained from the dried ripe fruit of *Petroselinum sativum* or garden parsley. *Apiol* is a commercial preparation of the drug.

* SENECIO

Synonyms. Ragwort, Life Root

The entire plant of *Senecio aureus,* a perennial herb of the northern and western parts of the United States.

Action and Uses. These drugs are irritant and ecbolic, but have no indications in veterinary medicine.

* Unofficial.

MYRRHA — MYRRH

Synonym. Gum Myrrh

Myrrh is a gum resin obtained from one or more species of *Commiphora,* small trees of eastern Africa and Arabia. It occurs in the form of irregular shaped tears, brownish red in color, agreeable aromatic odor and bitter taste.

Doses and Preparations.

Tinctura Myrrhæ, 20 per cent.
* *Tinctura Aloes et Myrrhæ,* 10 per cent of each.
* *Mistura Ferri Composita,* see iron, p. 405.
* *Pilulæ Aloes et Myrrhæ,* Aloes 2 gr.; myrrh 1 gr.
Pilulæ Rhei Compositæ, Dog, 1 pill.

Action and Uses. Myrrh is an emmenagogue, stimulant to mucous membranes and a stimulating expectorant. As an emmenagogue it is usually combined with iron, or aloes. As a stimulant to mucous membranes, the tincture is often diluted with water, or solution of potassium chlorate, and used as a wash or gargle, in stomatitis, etc., as in the following prescription.

℞ Potassii Chloratis .....gr. xl
Tincturæ Myrrhæ ..... ℥ jss
Tincturæ Benzoinæ Comp. ..... ℥ vj
Liquoris Antiseptici N. F. q. s. .....ad. ℥ iv

Teaspoonful in two ounces of water as a gargle or wash every 4 hours.

Myrrh has been replaced by more efficient agents as an espectorant.

* HEDEOMA

Synonym. Pennyroyal

The leaves and tops of *Hedeoma pulegioides,* an annual herb of North America. It contains a volatile oil, a bitter and tannic acid.

* TANACETUM

Synonym. Tansy

Tansy is the leaves and tops of *Tanecetum vulgare,* a perennial native to Europe and Asia but naturalized to the United States. Active principle is a volatile oil.

* SABINA

Synonym. Savine

The leaves and tops of *Juniperus Sabina,* an evergreen shrub of northern continents. Its activity depends upon a volatile oil.

* Unofficial.

* RUTA

Synonym. Rue

This is the leaves of *Ruta graveolens,* a perennial, indigenous to southern Europe but cultivated in this country.

Action and Uses of the Above. All depend upon a volatile oil for action and produce the usual symptoms following the administration of irritant volatile oils. They have been recommended as ecbolics and emmenagogues, but are dangerous to use since the irritation they set up on the gastrointestinal tract may be fatal without producing abortion. The oil of rue is the basis of the ear treatment of fistulous withers by the laity.

UTERINE SEDATIVES

A uterine sedative is an agent to lessen the uterine flow, quiet the organ and lessen the danger of abortion. But one drug, Viburnum prunifolium, has been recommended and used for this purpose. The action is directly opposed to the ecbolics.

VIBURNUM PRUNIFOLIUM

Synonym. Black Haw

The bark of *Viburnum prunifolium,* a tall flowering shrub common in the middle and southern United States.

Preparations and Doses.

Fluidextractum Viburni Prunifolii. Mare and cow ʒ j—iv; 30—60. Bitch ♏xx—ʒij; 1.5—8.

Extractum Viburni Prunifolii. One-fourth the dose of the fluidextract.

Action and Uses. Viburnum contains a bitter, resin, alkaloid, valerianic acid, and tannin, together with other less important ingredients. It is particularly recommended to quiet the uterus in threatened abortion, but there is no experimental evidence to show that it has any action in these cases. Since it contains a considerable amount of tannic acid, it may serve as an astringent in diarrhea, and as an astringent wash in pharyngitis, etc. Large doses cause progressive muscular weakness, ending in complete central nervous and cardia paralysis.

* VIBURNUM OPULUS

Synonym. Cramp-bark

This is the bark of a high shrub (high cranberry). It contains considerable tannin and is used as an astringent. It has been recom-

* Unofficial.

mended in colic and muscular cramps, hence the name, cramp-bark. It is of no importance in veterinary medicine.

GALACTAGOGUES

Synonyms. Lactics, Galactics, Stimulants to Milk Secretion

These are agents which increase the secretion of milk.

Action and Uses. The different defects in milk secretion are very important in cattle practice. The best known conditions are agalactia (absence of milk), watery milk, excessively fat milk, premature curdling, failure to butter, putrid, roapy, blue, red and yellow milk. Beginning with premature curdling, the rest of the defects are due to external infection and should be treated as such.

Galactagogues may be grouped as direct and indirect, the former acting directly upon the udder and the latter upon the general condition of the animal. Since most remedial defects result from digestive and other disturbances, an improvement in condition will bring about an increase in the amount of milk. The indirect galactagogues include especially the aromatic bitters and alkalies which improve digestion and consequently increase the milk secretion.

Cutaneous stimulation applied directly to the udder stimulates the secretion reflexly and is an indirect galactagogue. Frequent milking, rubbing the udder with nettles, or the application of electricity will show the same result.

Sulphur, antimony preparations and probably solution of the pituitary body are direct galactagogues. The first two produce the same activity in the mammary glands as upon other glands of the body while pituitary extract is believed to increase milk secretion through a direct action on the gland together with an increase in blood pressure. It is not clear just how the secretion of milk may be influenced but it is believed that the mammary glands are subject to several influences as in case of other glands.

Solution of the pituitary body will increase the amount of milk and fat for a short period of time in healthy animals. The results obtained with eserine, pilocarpine and pilocarpidine are contradictory. With the exception of solution of the pituitary body these agents have generally proved unsuccessful in healthy animals.

ANTIGALACTAGOGUES

Synonyms. Antigalactics, Lactifuges, Alactics

These are agents which decrease the secretion of milk.

It is sometimes necessary to decrease the secretion of milk, especially so in some cases of nonpregnant bitches in estrum. It may also be desired when the animal is to be fattened or in animals in which lactation persists after death or removal of the off-

spring. For this purpose laxatives, potassium iodide, alum and tannin may be of more use if at the same time the feed is gradually reduced and the interval between milking increased and finally stopped.

Oil of rosemary or hemp in the form of local applications have some reputation for this action.

APHRODISIACS AND ANAPHRODISIACS

Synonym. Ecrotics

Aphrodisiacs are agents which stimulate the sexual desire and increase the virile power. Since sexual impotence may be the result of various conditions, the treatment must vary accordingly. As a general rule the cause of impotency in animals unless due to some lesion of the tract can be traced to some fault of the nutrition of the body, such as obesity, which usually results from too little exercise and a too liberal diet or errors in diet. In some cases it may be due to anemia, and in others to a phlegmatic nervous disposition. Rarely is impotency in animals due to nervous depression and psychic influences as in man.

In some of the above cases dietary measures are all the treatment necessary. In others, exercise is needed. If there is reason to believe that there is nervous depression, some of the nerve stimulants should be used.

The most important aphrodisiacs are:

Nux Vomica and Phosphorus	Strychnine Damiana	Cantharides Yohimbine

Nux Vomica. This drug serves two purposes. It exerts a general tonic effect and at the same time stimulates the sexual centers in the cord.

Phosphorus. Phosphorus has quite a reputation as an aphrodisiac. It is supposed to produce its action through a stimulation of the nervous system. There is no doubt but that it is frequently of considerable service in impotency due to lowered nervous conditions.

Cantharides. This drug produces whatever action it may have as an aphrodisiac simply by irritation of the bladder and urethra as it is excreted. It frequently causes sexual excitement and erections but for this effect it is necessary to use large (unsafe) doses.

* **Damiana.** This is unofficial. It has long been held as an efficient aphrodisiac. It probably produces any benefit by stimulation of the nervous system.

* **Yohimbine.** This is an alkaloid or a mixture of alkaloids obtained from the bark of a tree, *the yohimbe,* or *cameroon tree.* It is indigenous to the Cameroons. The salt used is the hydrochloride and can be obtained only through Lehn and Fink, of New York.

* Unofficial.

Yohimbine has some recommendation as an aphrodisiac. Its action was for a time considered as specific, in that it produced a local congestion of the penis and testis. This congestion has been found, however, to be due to a general dilatation of the vessels and not to a specific local effect. Its aphrodisiac action is said to be procured in a very short time, almost immediately, in case of the lower animals, but it is usually necessary for men to take it for a long time.

Doses. H. grs. ¾—1½; 0.05—0.1. D. gr. 1/64—⅙; 0.001—0.01; 3—6 times daily, for several days, per os.

ANAPHRODISIACS

These are agents which lessen sexual desire. Most of them are nerve depressants. The following have the best reputation for this action:

Bromides	Camphor
Hyoscine	Lupulin

They are particularly recommended in nymphomania. The bromides and possibly hyoscine are the best. Camphor in the form of the monobromate often serves well. These agents are but little used in veterinary medicine because animals afflicted with such a condition can be better and permanently cured by removal of the ovaries or testes.

CHAPTER XVII

DIAPHORETICS AND ANTIHYDROTICS

DIAPHORETICS. SUDORIFICS

DIAPHORETICS are agents which increase the secretion of sweat, while diaphoresis is profuse sweating. As a class of drugs they are of minor importance in veterinary practice, since the horse is the only animal with well developed sweat glands in a large area of the skin. Cattle do not possess them to any extent and dogs and cats only in the pads of the feet. Diaphoresis may be produced in the following ways:

1. *Directly increasing the secretory activity of the sweat glands.*
   a. Stimulation of the sweat glands either directly or reflexly.
   b. By stimulation of the peripheral nerve endings or glandular cells.

II. *By action on the circulation in the skin.*
   a. Locally. Irritation of the sensory nerves of the skin. Counterirritation.
   b. Systemically.
      1. Indirectly. Rise of blood pressure if the cutaneous vessels are not simultaneously constricted.
      2. Directly. Dilatation of the cutaneous vessels either directly or reflexly or paralysis of the constrictor mechanism.

The character of the sweat differs also as to whether it is produced by I or II above. In I, produced by action on the glands, the sweat is more concentrated and less alkaline, the skin being cold and bloodless. This is the so-called "cold sweat" seen in collapse and is usually and rightly considered a serious symptom, as it is an indication of asphyxia. It is caused by stimulation of the sweat center by the CO_2 in the venous blood.

In II, sweat produced by increased circulation, the skin is warm and red (in unpigmented spots). This sweat is low in solids and resembles a serous exudate. Dilatation of the cutaneous vessels produces an increase in sweat when other conditions are favorable yet the sweating mechanism may be entirely independent of this dilatation.

This is shown by the dilated condition of the vessels of the skin in fever with dry skin and in the cold sweat mentioned above.

Diaphoresis may be produced by:

1. *Application of heat.* As hot air, vapor, water or sand baths.

2. *By preventing heat loss and increasing heat production;* this is done either by preventing the loss of heat through evaporation (cover of some impervious material) or by protecting the skin from the external atmosphere. Blankets act partly in both ways.

3. *Supplying heat in form of hot drinks.*

4. *Dilatation of the cutaneous vessels.* In this instance probably alcohol in hot drink is superior in man at least. Then next probably comes spirits of nitrous ether. This same dilatation may be produced by irritation of the cutaneous nerves either from the circulation (aconite) or by counterirritation (sinipism).

5. *Nauseants.* One of the characteristics of the nauseant stage of emetics is sweating. Any emetic may be used for this purpose whose action is easily controlled, or restricted to the desired action. Dover's powder is probably the best example of this action as it possesses the additional narcotic and diaphoretic effect of morphine.

6. *Stimulation of the sweat center.* Camphor is efficient in this manner although ammonia and especially liquor ammonium acetate are probably more useful. In this group belong the whole pilocarpine series although pilocarpine alone is used in practice.

The sweat glands are also stimulated by muscular exercise and strong emotion but these cannot be utilized in medicine.

GENERAL INDICATIONS FOR DIAPHORETICS

In the early days of medicine sudorifics were used for a large number of purposes and conditions. Then they were practically discarded for a while and only comparatively recently has their use been revived. Their uses may be summarized as follows:

1. Remove fluid from the body.
2. Remove injurious substances from the body.
3. Promote a normal condition of a disturbed circulation.
4. Relieve the kidneys.
5. Increase the alkalinity of the tissues.
6. Ophthalmology.
7. Reduce temperature in fever.

1. Remove Fluids from the Body.

a. *Promote absorption of dropsical effusions.* They are of no practical use in inflammatory local effusions as in the pleura and pericardium.

b. *In the treatment of obesity.* Here they are occasionally used according to the following plan: The carbohydrates are withheld

at the same time. The object is to compel the body to form its necessary amount of water from combustion of the adipose tissue. Any diaphoretic may be used except hot drinks.

2. Remove Poisons. Either those substances introduced from without or formed in the body. They are quite valuable in poisoning by As., Pb., Hg., nicotine, morphine, and fevers.

3. Reestablish a Disturbed Circulation in the Skin, and in this manner relieve congestion of the internal organs. It is for this purpose that they are employed in colds, rheumatism, etc., or a cold skin from any cause. To relieve a local congestion as in pneumonia or inflammation of the lungs, pleura, etc., the same or even better results may be obtained by counterirritation.

4. Relieve Inflamed or Overworked Kidneys.

5. Increase the Alkalinity of the Tissues. In such cases as gout, oxybutyric acid (diabetic coma), etc. For this purpose they are of but little use in veterinary practice.

6. Ophthalmology. They have been found useful in congestive and exudative lesions of the uvealtract, in retinal displacements and toxic blindness. They are of absolutely no value in atrophic or cicatricial lesions.

7. Reduce Temperature in Fevers. The most common are:

Pilocarpine	Spirits of nitrous ether
Opium	Ammonium acetate
Ipecac	Warburg's tincture

Pilocarpine is used principally in renal dropsies. It is not usually effective in local effusion of an inflammatory nature as in effusions in the pleura or pericardium. In the horse, the only dumb animal which sweats uniformly, pilocarpine seems to have a more specific action on the salivary than the sweat glands. Hence it is of but little service as a sudorific.

Opium. As a diaphoretic opium is usually given in the form of Dover's powders. It has a mild sudorific effect and is useful in breaking up acute catarrhal conditions of the respiratory tract and relieving so-called muscular rheumatism.

Spirits of Nitrous Ether. Therapeutic doses of this agent act as mild diaphoretics, diuretics and antispasmodics. Its diaphoretic effect is more marked if the patient is kept well covered while its diuretic effect is more marked if the patient is not well covered. It is useful as a diaphoretic in the mild febrile conditions of the young in small doses well diluted with hot water repeated at frequent intervals.

Ammonium Acetate. This is usually used as the official solution — Liquor Ammonii Acetatis. It serves as either a diuretic or diaphoretic according as to whether the patient is kept warm or cool.

It is frequently used as a vehicle for spirits of nitrous ether or aconite.

ANTIHYDROTICS

These are agents which act exactly opposite to those just discussed. That is, they decrease the secretion of sweat. Theoretically they may act by:

1. *Lessening the irritability of the sweat centers.*
2. *By depressing the peripheral fibers of secretory nerves or the the gland cells themselves.*
3. *By depressing the respiratory center.*

In regard to the last method Brunton has called attention to the close relation between respiratory depression and the occurrence of profuse sweating. He states that when the respiratory center is exhausted from any cause it responds less readily than the sweat centers to the stimulating influence of venous blood in consequence of which profuse sweating occurs. This accounts for the fact that respiratory stimulants are frequently efficacious in controlling the night sweats of tuberculosis. The most important antihydrotics are:

Atropine	Agaricin
Sulphuric acid	Picrotoxin
Camphoric acid	Tellerium compounds

Thallium acetate

Gallic acid, ergot and zinc oxide have also been employed but are of very doubtful value. Certain external remedies are also useful in excessive sweating, such as sponging with a solution of vinegar and water, or a hydroalcoholic solution of tannin or alum. A weak solution of formalin answers well but is irritant to the eyes and respiratory tract. There are no specific indications for the use of antihydrotics in veterinary medicine, and they are used in human practice principally in night sweats of tuberculosis.

CHAPTER XVIII

HEMOSTATICS OR STYPTICS

THESE are agents used to control hemorrhage. They may be conveniently classified as those which act locally, "styptics," and those which affect the body generally, "general hemostatics." They all arrest hemorrhage in a manner similar to nature in spontaneously closing a bleeding vessel. Ordinarily if an artery is cut, it contracts within its sheath and the tissues fall in around the cut end. In addition, if the bleeding is severe, the blood pressure will fall and the coagulability of the blood increase. The choice of an hemostatic depends upon the location of the hemorrhage and its source; that is, is the bleeding point accessible, and is the source of the blood arterial, venous or capillary? Some mechanical means should always be used to arrest hemorrhage from a large artery. This may be accomplished either by ligature, clamp, forceps, torsion or the actual cautery. Slight or capillary hemorrhage may often be quite effectively stopped by local applications of astringents or by vasoconstrictors. Among the most satisfactory of these agents is cold, either in the form of cold water or ice. Adrenaline and the styptics (astringents), tannin, alum, etc., are also quite serviceable. In addition to the above some method must be employed to control distant, inaccessible hemorrhages which can be reached only through the circulation (general hemostatics).

The principal local hemostatics are:

1. Mechanical measures
2. Cold
3. Adrenaline.

(All act by closing the vessels either by direct compression or through vasoconstriction.)

4. Agents favorable to the formation of a clot. Absorbent cotton, gauze. Cobweb has been used for ages but is dirty.
5. Those which act by precipitating the proteids of the blood. Astringents, tannin, alum, etc.

The general hemostatics are:

1. Tannic acid group of drugs and mineral astringents.
2. Agents to lower blood pressure.
3. Vasoconstrictors, adrenaline, ergot, etc.
4. Coagulants.

1. **Tannic Acid Group.** The various members of this group have been recommended as general hemostatics but there is no foun-

dation for their use with the exception of the fact that they do arrest hemorrhage when applied locally. The tannic acid preparations undergo changes before they are absorbed which render them useless for hemorrhages beyond the digestive tract. On the other hand, there is little reason to believe that the mineral astringents circulate in the blood in sufficient concentration to be in any way effective.

2. Agents to Lower Blood Pressure. This is not a very important group therapeutically but they should not be overlooked. They might be used unless the hemorrhage has been profuse. One of the first considerations of the treatment of internal hemorrhage is to put the patient at rest and keep it as quiet as possible, since rest favors the formation of a clot, while motion favors bleeding or breaking down of the clot. Some of the hypnotics are particularly serviceable for this purpose. Morphine is exceptionally useful in dog and man. The bleeding part should be raised as much as possible as this tends to lower blood pressure in the part.

Vasodilators do not give very satisfactory results. As hemostatics they should dilate all the vessels except the bleeding ones but of course this action is impossible to obtain. They would be indicated, if at all, in hemorrhages from vessels not easily dilated as in the muscles and lungs.

3. Vasoconstrictors. These are in a class similar to the dilators. That is, for therapeutic action to control hemorrhage, they should constrict the bleeding vessels but dilate the others. The great obstacle in the path of the constrictors in arresting hemorrhages is that a general vasoconstriction is accompanied with a rise of blood pressure. Consequently although these agents may constrict the bleeding vessels, in so doing they raise arterial tension to such an extent as to equal if not more than compensate for any effect the constriction would have upon the bleeding part.

There are a few exceptions to the last statement, however, as there is no doubt but that ergot and hydrastinine are very efficacious in post partum hemorrhage, but their value in other hemorrhages is very doubtful.

Adrenaline belongs to this group and clinical experience seems to indicate that it is of considerable value in distant hemorrhage although it does increase blood pressure.

4. Coagulants. These drugs increase the coagulability of the blood which is desired when there is severe bleeding from slight wounds as in purpurea hemorrhagica, hemophilia, epistaxis, hemoptasis, renal and intestinal hemorrhage, etc. The principal drugs used for this purpose are gelatin, calcium lactate and calcium chloride. With the exception of gelatin, stypticin and the calcium salts, the different members of these groups have been discussed in other places.

COTARNINAE HYDROCHLORIDUM

Synonym. Stypticine hydrochloride

This is an artificial alkaloid obtained by hydrolyzing narcotin, one of the opium alkaloids and treating the resulting cotarnine with hydrochloric acid. It resembles hydrastinine in its composition, occurs in the form of a yellow powder or crystals, has a bitter taste and is freely soluble in alcohol and water. It has been recommended in the same conditions as hydrastinine and as a local remedy to arrest hemorrhage. It may be applied in solution with a tampon and is said to be valuable in persistent epistaxis.

GELATINUM

Synonym. Gelatin

Gelatin is the dried product of the action of boiling water upon animal tissues, such as skin, ligaments, tendons and bones. It occurs in transparent thin sheets and is without odor or taste. It is insoluble in cold water, soluble in hot water and if in solutions over 2 per cent. gelatinizes upon cooling. Solutions heated above 230° F. do not gelatinize.

Preparation.

Gelatinum Glycerinatum. Glycerinated gelatin. Gelatin 100 gms., glycerin 100 gms., water enough to make 200 mils.

Action. Dastre and Floresco, in 1896, demonstrated that the blood drawn from a dog which had received intravenously a 5 per cent. solution of gelatin coagulated almost immediately and that the same results could be obtained by adding gelatin to the blood outside the body. As proof that the solidification was due to clotting and not to gelatinizing, they also demonstrated that the coagulation would occur at a temperature of 38° C. (100.1° F.) at which a 5 per cent. solution of gelatin will not jellify. Moreover they also demonstrated that the action could be obtained in solutions below the necessary per cent. for jellifying (2 per cent.).

Lancereaux and Paulesco (1898) determined that subcutaneous injections of gelatin were equally effective as intravenous injections for increasing the coagulability of the blood. It has not yet been determined whether its action is effected by digestion although some practitioners have reported success in hemorrhages when it has been administered by mouth or rectum. There has been no satisfactory explanation advanced to account for the action of gelatin upon the coagulability of the blood.

Hogan (1915) reported several experiments and actual cases in human practice in which gelatin has been used successfully in shock.

It is well known that the ordinary infusion solutions (physiological salt solution, Ringer's solution, Lock's solution) stay in the blood vessels but a short time and consequently the improvement, which is marked almost immediately, often wears off within an hour or so. On the other hand it is known that colloidal solutions will remain in the blood vessels for a considerable time.

On account of the difficulty of transfusion of blood, injection of blood serum, ascitic or hydrocele fluid, he sought a colloidal solution which might be used. His reports of experiments and actual cases show that gelatin solutions may be used intravenously in shock without danger and with very gratifying results.

Therapeutics. Gelatin has proved very serviceable in both internal and external hemorrhage and in shock. As a local remedy it has proved very efficient in epistaxis, hemorrhoids, and oozing from open wounds. It has been reported as beneficial in internal hemorrhage such as hemoptysis, hemophilia, hematuria, and enterorrhagia. For local hemorrhages a 10 per cent. solution may be applied upon tampon. The solutions should be sterilized and may have added to them a small amount of phenol to prevent putrefaction.

1. *For Systemic Action.* Gelatin may be given subcutaneously in doses of 15 to 45 grains for dogs or 2 drams to an ounce for horses, in a 5 to 10 per cent. solution once or twice daily. It is best administered in normal salt solution. A 10 per cent. solution may be prepared by dissolving 1½ ounces (50 gm.) of gelatin and 35 grains (2.5 gm.) of salt in a pint of water (500 mils). This should be clarified and sterilized by the fractional method for three or four consecutive days. A careful sterilization is necessary because tetanus often follows the subcutaneous use of gelatin.

According to some authorities, gelatin will produce good results when administered per rectum as in the following manner: A 6 per cent. solution of gelatin in normal salt solution, to which a little opium may be added to prevent expulsion, is used. (The opium is of questionable value at most.) The doses are for small animals 1½ ounces, and for large ones 10 ounces to one pint, warmed to body temperature. This should be repeated after 4 or 5 hours if there is still danger of hemorrhage. The bowels should of course be first cleansed by an enema, preferably of boiled water.

2. *In Shock.* Hogan recommends the following solutions, but specifies that the gelatin must be fresh and of the highest quality:

Twenty-five grams of the purest gelatin, 1.5 gm. of sodium chloride and 100 mils of distilled water are placed in a flask and boiled for 15 minutes. The resulting solution is filtered through heavy paper in a hot funnel and then autoclaved for an hour at 124° C. It is then chilled in an ice box. The gelatin has the proper colloidal qualifications if it solidifies under these circumstances. It is to be kept in this form until needed. In order to prepare the transfusion

mixture, the gelatin is warmed until it melts when it is added to 1000 mils of 0.9 per cent. sodium chloride, to which has been added 2 gms. of sodium carbonate crystals, and warmed to body temperature. The usual amount administered in man is 500 to 750 mils.

CALCIUM CHLORIDE AND CALCIUM LACTATE

Calcium chloride occurs as white, translucent, hard fragments, odorless, of a sharp saline taste, and very deliquescent. It is soluble in 1.3 parts of water and 8 of alcohol.

Calcium lactate is a white crystalline powder, not readily soluble in water unless freshly prepared.

Dose of either salt is:

H. ℥ ss—j; 15.—30. D. gr. v—xx; 0.3—1.3.

Action and Uses. These salts possess the power of causing the blood to coagulate more readily outside the body and according to some investigators (Wright) the same result is obtained when they are administered internally. They have been recommended in hemophilia and in general the same conditions in which gelatin is recommended as a hemostatic but their action is uncertain.

CHAPTER XIX

IRRITANTS AND COUNTERIRRITANTS

Irritants are agents which cause hyperemia and inflammation when applied to the surface of the body. When applied for the relief of disease in remote parts of the body they are called counterirritants.

Counterirritation or irritation of the skin for internal diseases, is a practice which dates back to the earliest days of medicine. The theories upon which the practice is based have changed very frequently to meet the advances in medical science. In the early days when disease was considered as an entity, or humor, the theory of revulsion or derivation was much in vogue. The purpose of the irritation of the skin was to draw the disease from the deeper portions to the skin. Then it was held that if fluid was drawn to the skin, congestion of the internal organs would be relieved. This theory has also held more or less even in modern times. It was also noticed very early in medicine that counterirritation often relieved the pain in internal organs. The irritation was obtained in various ways. Many drugs were used, also many mechanical devices, such as burning, electricity, or setons or rowels introduced. The last two named agents not only served as irritants but also supplied a means of exit for the humor. Most of these theories are interesting only from a historical standpoint, but counterirritation is still used for the relief of pain of internal organs, and to produce a change in the distribution of blood.

These agents may be classified into three groups according to the intensity of their action. If they simply produce redness under ordinary conditions they are termed *rubifacients.* If the action is more intense and blisters are formed, they are termed *vesicants,* while if they produce pustulation in the necks of the glands, they are termed *pustulants.*

Action. The action of these agents may be described as local and remote.

Local action. This is evidenced by a feeling of warmth to the part, burning or pain; the skin becomes reddened, congested and sensitive. These symptoms last for some time and recede gradually. Some desquamation may follow if the irritant has been applied for some time. If a stronger irritant is used, the same symptoms as described above will occur, but will be followed by small vesicles under the epidermis. These may coalesce so that a large vesicle or blister is formed. Upon removal of the vesicant, the fluid is slowly ab-

sorbed, leaving an empty sac under the skin. If still greater action is secured, the first two steps will be repeated, but these will be followed by small pustules. The reason for the distant separate pustules instead of a diffuse inflammation is based upon the theory that the agent is unable to pass through the horny layer of the skin but can pass in and irritate the orifices of the glands. The local effects produced from irritants are exactly similar to other forms of inflammation, pain, swelling, redness, etc.

Remote Action. Certain changes in the entire organism always accompany local irritation. These are due to stimulation of various centers in the medulla and are generally believed to account for any benefit from counterirritation. The centers particularly involved are those regulating the heart, vasomotor and respiratory. A moderate degree of irritation accelerates the heart, through some unknown manner, while stronger irritation slows the heart through stimulation of the vagus center. Blood pressure is raised by moderate stimulation but on account of the decreased rate of the heart is lowered by sharp irritation. The increase in blood pressure is probably due to stimulation of the vasomotor center which constricts the blood vessels over wide areas. This constriction is not general but is more pronounced in the abdominal vessels, less so in the limbs and skin. The respirations are stimulated by mild irritation but depressed by stronger ones.

Methods of Producing Irritation and Counterirritation.

1. Bacterial.
2. Friction and massage.
3. Acupuncture.
4. Scarification.
5. Temperature.
6. Cupping, venesection and leeches.
7. Electricity.
8. Drugs.

1. *Bacterial.* This method was widely used in the early days of medicine but is now obsolete. It consisted in using setons or rowels, which were pieces of gauze or other fibrous material, pushed under the skin and allowed to suppurate. Occasionally a piece of some vegetable was placed beneath the skin to act as a foreign body and cause suppuration.

2. *Friction and massage.* Here the benefit is due partly to the friction produced and partly to the massage of the parts. The benefit obtained from the use of liniments is partly due to the friction produced during their application.

3. *Acupuncture.* This consists of thrusting fine needles deeply into the tissues. It causes considerable inflammation and is said to

be quite effective in lumbago and sciatica. It is rarely used in modern medicine.

4. *Scarification.* This consists of making numerous small incisions with a knife or other instrument such as rubbing with needles. The irritant may then be rubbed in and will have a greater degree of action.

5. *Temperature.* Cold applications are often used for their remote reflex action, while some form of heat is used for local effect. The actual cautery is often very serviceable for deep seated affections.

6. *Cupping, etc.* Cupping or leeching simply brings about a change in the distribution of blood to the parts. A small amount is sometimes extracted in this manner. Leeches act in the same way but are not used in modern medicine. See p. 110.

7. *Electricity* is used as a stimulant to prevent atrophy of muscles, in paralysis and as a counterirritant.

8. *Drugs.*

Uses of Irritants and Counterirritants.

1. In skin diseases.
2. Promote secretion of sweat.
3. For reflex action by affecting the central nervous system especially the medulla.
4. As counterirritants.
5. Relieve pain.
   (a) To change the distribution of blood and diminish deep chronic inflammation.
   (b) To remove exudate from connective tissue in a similar manner.
   (c) Relieve pain.
   (d) Tonic action.

1. *Skin Diseases.* Some long standing or chronic forms of skin disease are often benefited by the action of an irritant. This is particularly so in ulcers, chronic eczema, and slow healing wounds. Some of the milder irritants are usually employed such as the balsams, tar, or light painting with iodine.

2. *Promote Diaphoresis* (see diaphoretics).

3. *Reflex Irritation of Central Nervous System.* They may be used in this case to arouse the system in collapse and shock, and in narcotic poisoning. They may be given subcutaneously or by inhalation (ammonia). In the latter case the action is produced by irritation of the trigeminal nerve.

4. *Counterirritants.* (a) Local changes in the circulation of parts remote from the point of application can be accounted for in two ways: through a continuity with the seat of irritation, or by reflex action. In the former case an increased vascularity of the skin

may influence the neighboring organs in two ways. 1. Cause hyperemia of the organs along with its own hyperemia, or 2. may withdraw blood from the organs and leave them anemic. In one case a better blood supply is obtained for the part and better conditions made for the absorption of the exudate. The increased blood supply means an increased nutrition of the part which really aids nature in overcoming some pathological condition. Firing or blistering for spavin or diseases of the joints produces a reparative inflammation which assists nature in locking the bones together so that pain and lameness is relieved. At the same time it assists by producing a period of rest for the part which is also useful in these conditions.

The use of irritants for the removal of exudates from connective tissue can be explaned by the increased circulation and nutrition. To produce a change in the vascularity of the skin and remove inflammatory exudates, it is necessary to employ deeply acting and persistent stimulation.

5. *Relieve Pain.* It has been known for many years that the application of heat or counterirritants in certain superficial areas would relieve pain and inflammatory processes in the deeper organs. The use of counterirritants for this purpose was purely empirical but nevertheless effective and could not be satisfactorily explained for a long time. Mackenzie and Head working upon the inervation of the viscera have somewhat cleared up the matter in case of man. They found that disease of the viscera is often accompanied by tenderness of the skin and underlying muscles, and that the pain arising in these cases is referred to this area and not to the organ involved. Thus in painful diseases of the stomach, tenderness is often found in the skin and muscles of the epigastrium. In heart disease the pain is often in the left chest wall and shoulder extending down the arm. It was found also that the internal organs and definite areas upon the surface of the body receive their nerve supply from the same spinal or cranial segment and that irritation of one will react upon the other. It is interesting to know that the areas marked out experimentally on the surface of the body, as those affected by internal disease, correspond very closely to those areas used empirically, and upon which experience has shown irritation to be most beneficial.

Counterirritants are usually employed in the form of liniments, i.e., in solution or suspension in oils or alcohol. These liniments are too numerous to mention. Likewise the drugs used for counterirritation are numerous and only those will be mentioned here that are used especially for this purpose.

Most important counterirritants are:

Cantharides	Ammonia	Red iodide of mercury
Mustard	Chloroform	Mercuric chloride
Iodine	Camphor	Euphorbium
Capsicum	Aconite	Volatile oils

Those used for local systemic effect are:

Chrysarobin	Balsam of Peru
Oil of cade	Jequirty

CANTHARIS

Synonyms. Spanish Flies, Cantharides

This is official as the dried beetles, *Cantharis vesicatoria,* largely secured from the southern part of Europe. Its active principle is cantharidin, an anhydrid of cantharidic acid. It is a crystalline body forming soluble salts with alkalies.

Preparations.

Tinctura Cantharidis 10 per cent. H. ♏xxx—3j; 2.—. D. ♏ij—♏v; 0.13—1.

Ceratum Cantharidis. Cantharides 35 gms., Glacial acetic acid 2.5 mils, oil of turpentine 1.5 mils, yellow wax and rosin each 17.5 gms., and benzoinated lard 20 gms.

Collodium Cantharidatum, 60 per cent. Cantharides.

Externally and Locally. Applied to the skin, cantharides produces irritation, redness and burning, followed by vesication. If the action is allowed to continue, it may lead to pustulation, or ulceration and sloughing. When applied in properly prepared ointment, vesication will be produced in from 3—12 hours. The effects are not believed to extend very deeply, but it is one of the most useful blisters in veterinary medicine. But if the blister is too strong or used too freely, inflammation of the deeper layers of the skin may occur with suppuration and in extreme cases sloughing; the hair bulbs become injured and a permanent blemish results. It is also irritant to the mucosa. If applied to too large an area of the skin, absorption may occur and result in the symptoms to be described under internal action.

Internally. There is no effect of therapeutic doses upon the digestive tract except that of mild irritation. Through its elimination by the urinary tract, small doses are slightly diuretic, genito-urinary stimulant and aphrodisiac according to some authorities, although any aphrodisiac power is due to its irritant action on the mucosa as it escapes from the body. The action of large doses is discussed under toxicology.

Absorption and Elimination. Cantharides is absorbed from all surfaces. It is sometimes absorbed from the skin in sufficient amounts to give trouble and is always contraindicated in nephritis. It is almost entirely eliminated by the kidneys.

Toxicology. The symptoms of poisoning may be divided into two groups: those produced upon the digestive tract before absorption and those produced upon the genito-urinary tract during elim-

ination. In the former there are symptoms of severe irritation of the gastro-intestinal canal, burning in the mouth and throat, abdominal pain, dysphagia, thirst, ptyalism, vomiting and purging of bloody mucus. Prominent among the symptoms of irritation of the genito-urinary tract are pain in the lumbar region, frequent urination, vesicle tenesmus, with passages of a few drops of bloody albuminous urine, and in males, priapism. Erotic excitement sometimes takes place and abortion may follow from the results of the irritation of the drug upon the pelvic organs.

Treatment. Evacuate the stomach and relieve the local conditions by the free use of demulcents. Administer some anodyne to combat the pain. Avoid fatty substances, since they tend to dissolve the cantharidin and favor its absorption. The strangury may be treated by applying hot packs to the posterior part of the abdomen.

Therapeutics. *Externally.* It is chiefly used as a vesicant and counter-irritant. The action is too slow and irritating and the danger from absorption too great for use as a counterirritant over large areas (chest and abdomen) in pneumonia, pleurisy, colic, etc. Mustard, turpentine and heat are to be preferred for these diseases. A cantharideal blister is often serviceable in acute inflammation of the brain or the meninges and should be applied over the region of the poll. It may also be useful in acute laryngitis when applied to the throat, or for paraplegia when applied over the diseased parts.

Cantharides is the remedy most often used for counterirritation in cases of rheumatism of muscles or joints, placed over the diseased parts or, if the disease is acute, near by. It is also often prescribed for the treatment of disease of the bones, joints, ligaments, bursæ, tendons, etc. In diseases of the bones with exostosis, a blister is usually applied after the use of the actual cautery, while in many cases a strong blister, combined with complete rest will often relieve these conditions.

A cantharidin or other blister is often serviceable in closing an open joint. According to some authorities they are also used to close small umbilical hernias.

As a stimulant to the growth of hair in alopecia. Here it is usually employed in the form of the tincture.

Internally. Cantharides is rarely used internally, but may be of service in incontinence of the urine, due to relaxation of the neck of the bladder, and as a stimulant in cystitis and pyelitis. It has been recommended as an aphrodisiac, but the necessary doses for this action are unsafe.

Administration. For internal use the tincture should be employed. For external purposes, it is usually mixed with some fatty material, volatile oil or alcohol, and applied as an ointment or liniment.

The following are representative prescriptions for cantharides blisters:

℞ Cantharides.
Ceræ Flavæ .....āā ℥ ij
Adipis ..... ℥ xiv
M. For external use.

A stronger one is,

℞ Cantharides.
Euphorbii aa. ..... 2.
Hydr. Chl. Corros. ..... 1.
Petrolati ..... 8.
Cerati ..... 12.

or for deep action:

℞ Cantharides ..... ℥ j
Hydrargyri Iodidi Rubri .....āā ℥ j
Adipis ..... ℥ j

Cautions in the Application of Counterirritants.

1. Cantharides is not a safe blister for dogs, because it is liable to cause too severe action. Furthermore, it may be absorbed from the skin or licked off by the animal in sufficient quantity to produce toxic action.

2. Cantharides is contraindicated as a blister in urinary affections or cases of general debility or weakness.

3. Counterirritants should not be used in acute inflammatory conditions.

SINAPIS ALBA (White mustard) and **SINIPIS NIGRA** (Black mustard).

The former is the seed of *Sinipis alba,* and the latter the seed of *Brassica nigra.* Both varieties are quite widely distributed in Europe and America, often growing as weeds, but frequently cultivated. The mustard of commerce is usually a combination of both varieties.

Dose, Carminative. H. 3ij—iv; 8—16.
Dose, Emetic. D. 3j—ij; 4.—8. In a cup of warm water.

Constituents. White mustard contains myrosin, a ferment, and sinalbin, a glucoside. In the presence of water the ferment acts upon the glucoside and separates from it an acrid fixed oil, Acrinyl-isothiocyanate. The black variety also contains the above ferment, together with sinigrin, which in the presence of water yields a very irritable, volatile oil (Oleum Sinapis Volatile — allyl-isothiocyanate). It is far too irritant to be used alone but may be used as

spiritus sinapis. This is composed of volatile oil of mustard, 1 part, alcohol, 50 parts.

Preparation.

Emplastrum Sinapis. For external application.

Action. If mixed into a paste with water and applied to the skin mustard produces heat, redness, burning, pain, and if the action or contact is prolonged, vesication. Since the vesicles do not heal readily, mustard is used externally almost entirely as a rubifacient. It is very rapid in action. If applied as a paste or as the official plaster, it is often very serviceable for the relief of pain in various conditions, such as gastritis, pleurisy, pneumonia and rheumastism. The plaster may be made as follows: Mustard or mustard and flour in different strengths up to equal parts are mixed into a paste with warm water, and either applied directly upon the part or spread between two layers of muslin. Hot water should not be used because it destroys the ferment which is required to produce the irritant oil from the glucoside. The spirit can be used instead of the plaster, and has the advantage of being more cleanly and more easily removed. Plasters or other applications should be left on for a short time only or until the skin becomes red, then removed, as a general rule, but may be left longer if the pain still persists. It is not a good plan, however, to repeat the plaster frequently for counterirritant effect, because considerable irritation may result.

Internally. Mustard is used as an emetic and carminative. As an emetic it is very active and produces action by directly irritating the walls of the stomach. It should be given in doses of one to two teaspoonfuls in a half cup of tepid water, and repeated in a short time if necessary.

As a carminative it is entirely used for the large animals. It appears particularly serviceable in old animals with intestinal catarrh, due to atony of the bowels, and is often prescribed along with Nux vomica and Carlsbad salts for this condition.

***Thiosinamine (allyl-sulphocarbamide).** This is produced by heating oil of mustard with alcohol and ammonia. The irritating properties of the oil are lost in the process. It occurs as a white crystalline principle and has been recommended for destroying scar tissue and in lupus. It can be given dogs hypodermically in doses of 1 or 2 grains in glycerin and water or by the mouth in daily doses of 3 grains. The injection need not be at the site of the lesion. The results of its use are still in some doubt.

***Fibrolysin.** This is the trade name for a sterile solution of a double salt of thiosinamine and salicylate of soda. It is freely soluble in water. It is equivalent in action to the first named number of its constituents, but may be given subcutaneously, intramuscu-

* Unofficial.

larly or intravenously. Injections are made at intervals of 1—3 days and may require many repetitions. It is less irritant locally than thiosinamine. Its action is to soften scar tissues and perhaps to promote its absorption. Reports of its use are contradictory, many successes and failures having been reported. It has been successfully used in hypertrophied scars of the skin, in structure opacities of cornea, etc. It is said to be useless in corneal opacities of long standing.

It is contraindicated in active inflammatory conditions, in tuberculosis and in ulceration of the digestive tract.

It is marketed in ampules of 2.3 mils of solution, representing 3 grains (0.2 gm.) of thiosinamine.

CHRYSAROBINUM — CHRYSAROBIN

This is official as a more or less impure neutral principle, obtained from *Goa powder,* a substance found in the heart wood of *Vouacapoua Araroba,* a large tree of Brazil. Chrysarobin is a yellow crystalline powder, odorless, tasteless, slightly soluble in water, alcohol, chloroform and ether. It assumes a darker color on exposure to light, due to partial oxidation to chrysophanic acid.

Preparation.

Unguentum Chrysarobini, 6 per cent. in benzoinated lard.

Action and Uses. It is never used internally, but is a gastro-intestinal irritant. Large doses are irritant to the urinary tract to such an extent that they may cause nephritis. It is largely eliminated by the kidneys.

Externally it is a parasiticide and irritant.

Chrysarobin is one of the best agents we have for the treatment of psoriasis, but stains the skin yellow temporarily and may cause some dermititis. It is especially adapted where the patches are few and large, or to large patches in extensive cases. It may be absorbed from the skin sufficiently to cause internal disturbances if used too freely and should not be used upon the head, as the eyes and conjunctiva are very sensitive to it. It is prescribed as an ointment as

Chrysarobini	gr. x—lx.
Adipis	℥j.

or in suspension in collodion, 30—60 grains to the ounce. It may also be employed for ringworm when the areas are small.

OLEUM CADINUM. OIL OF CADE

Synonyms. Oil of Cade, Juniper Tar Oil, Oleum Juniperi Empyreumaticum

This is an empyreumatic oil distilled from the wood of *Juniperus Oxycedrus,* a shrub resembling the common juniper and growing

in southern Europe. It occurs as a thick brown liquid, has a tarry odor and taste, is partially soluble in alcohol, completely so in chloroform.

Action and Uses. These resemble those of oil of tar very closely. It is chiefly used as a stimulant application, in psoriasis, and chronic eczema. It is used in the form of an ointment as

℞ Olei Cadini ..... ℥ j–iij
Adipis ..... ℥ j
M. Ft. Unguentum.

or as a shake mixture, in alcohol, in the proportion of one part of the oil to 1 or 2 of alcohol.

ARNICA

Synonym. Arnica Flowers

This is official as the flowers of *Arnica montana,* a perennial of temperate regions of Europe, Asia, and America. It contains tannin, a volatile oil and a glucoside arnicin.

Preparation.

Tinctura Arnicæ. H. ʒss—j. D. ♏x—xxx.

Action. *Internally.* Small doses taken internally slow the heart and raise blood pressure. Toxic doses cause a feeble pulse, severe gastrointestinal disturbances, prostration and dilirium or stupor.

Externally. It causes redness and burning and occasionally severe inflammation. Although arnica has been recommended for internal medication in many diseases, the results of its use are much in doubt and there are no good grounds for its use internally.

Externally it is a favorite remedy, employed as the tincture, as a stimulating application in sprains and bruises.

* EUPHORBIUM

The dried juice of *Euphorbia resinifera.* It consists of a gum resin. Used rarely in practice and always as an adjuvant to other irritants.

* EPICARIN

This is a condensation product of cresotinic acid, used as a parasiticide, same as chrysarobin, but in about twice the strength.

BALSAMUM PERUVIANUM

Synonyms. Peru Balsam, Balsam of Peru

Balsam of Peru is a brownish black syrupy liquid, obtained by bruising the bark of *Toluifera Pereiræ,* a large tree of Central

* Unofficial.

America. It has a smoky vanilla like odor, and bitter persistent taste. It is soluble in alcohol, chloroform, and glacial acetic acid. It contains resins, cinnamic and benzoic acids and traces of vanillin.

Doses. D. ♏v—xxx; 0.3—2.

Uses. Expectorant and parasiticide. In the earlier days of medicine, it was used as a stimulating expectorant, but has been replaced by better drugs. It is useful externally as a stimulant to indolent wounds and in mange. For the latter purpose it may be used alone or with equal parts of alcohol, or in combination with sulphur in an ointment as

℞ Sulphuris Præcipitati.
Balsami Peruviani .....āā. ℥ ij
Olei Olivæ ..... ℥ j
Adipis, q. s. .....ad. ℥ ij
M. Ft. Ung.
Use as directed.

OTHER COUNTERIRRITANTS

Ammonia. This is an active counterirritant, especially if well rubbed into the parts or if the gas is confined. It is useful in liniments for sprains, bruises, swelling of the tendons, etc. It is one of the principal ingredients of veterinary liniments.

Oil of Turpentine. See the turpentine group of volatile oils. This is particularly serviceable as a turpentine stupe in the various inflammations of internal organs. Turpentine is one of the most useful counterirritants we possess. Combined with ammonia it is frequently employed as a liniment.

Capsicum. This is occasionally used as a counterirritant. Its action is not so strong as that of cantharides, and causes more pain than mustard. It may be used in some cases where a vesicant action is not desired, but where mild stimulation is indicated.

Iodine. This is well adapted for those conditions which require a mild but persistent action. The tincture is of service in laryngitis, arthritis, synovitis, etc. The action is persistent and renders the drug peculiarly adapted for the absorption of exudates. Preparations stronger than the tincture are frequently beneficial in exostosis. The following often proves serviceable in spavins, splints, etc.

Absorbent solution.

℞ Hydrargyri Chloridi Corrosivi .....grs. ij
Iodi ..... ℥ j
Ichthyolis ..... ℥ j
Glycerini ..... ℥ j
Alcoholis q. s. .....ad. ℥ j
M. et ft. solutio.
Sig. Apply every other day with a brush.

Croton oil and **red iodide of mercury** serve also as irritants. The former is generally too irritant for use upon any animal except cattle, the latter is very useful as a deep acting vesicant in diseases of the bones and tendons.

Chloroform, camphor, and aconite are employed as rubifacients, practically always in the form of a liniment.

CHAPTER XX

CAUSTICS

Synonym. Escharotics

These are agents which act by causing the death of tissues. The action of caustics produces a stronger degree of irritation than pustulation. This action may be due to inflammatory necrosis or to direct chemic action consuming the tissues (sulphuric acid), or precipitating the proteids (phenol). Tissue destroyed by chemical agents will always be preceded by inflammatory necrosis and chemic cauterization will always show three areas: the first or outside area of hyperemia and inflammation, inside this a layer or zone of necrotic tissue, and in the center a solution of cells which have been killed by inflammatory processes. These areas should be regarded in the light of different successive stages of the same action, and by proper dilution, the first or second stages may be produced without the succeeding ones.

Some of the caustics, such as arsenic, mercury, the stronger alkalies, acids and bromine, act by forming soluble compounds with the proteids of the tissues, while others, as most of the metallic salts, saline and organic irritants, kill the cells by precipitation of their proteids. If the corrosion leads to a loss of tissue, an inflammatory exudate will be thrown upon the surface, where it will coagulate. This exudate plus the products of the action of the irritant upon it and upon the cells, form the scab or eschar. This will vary in form with the nature of the chemical products forming it. Thus if the irritant exerts a solvent action on proteids, as in the case of the alkalies, the scab will be liquid, while if the product formed by the agent upon the proteids is insoluble, as in the case of metallic salts, the scab will be hard. This fact is very important because it determines the depth of the action of the irritant. If the scab is soft the irritant will penetrate it. Consequently the action cannot be controlled and will spread and extend deeply. On the other hand, if the scab is insoluble or hard it prevents deep penetration and the action can be easily controlled or confined to the desired areas. This explains why the strong alkalies are not practical for purposes of irritation, caustic action, etc., and why the metallic salts are to be preferred for these actions.

Caustics produce the same action upon the mucosæ of the intestinal tract if swallowed as upon the skin. The early symptoms begin

in the mouth with a burning sensation and pain followed by dysphagia and loss of tissue. The appearance of the mucosa of the mouth is important in cases of poisoning, because it is an aid in the diagnosis of the nature of the irritant. Alkalies form a transparent swelling of the mucosa, which is soon detached, leaving a scarlet colored inflamed area beneath. Corrosives, which form a precipitate with the tissues produce a grayish-white, opaque stain, which persists in the case of the mineral poisons. Strong acids change the hemoglobin of the neighboring parts to dark acid hematin, with a dark or brown stain. Nitric acid is an exception. This forms a yellow stain which differs from that of picric acid by being changed to an orange color by alkalies, while the picric acid stain remains unchanged.

The corrosion extends down the esophagus to the stomach and intestines. Gastroenteritis is consequently produced and is shown by the usual symptoms. The vomitus and feces are more or less bloody and in case of the strong acids, the vomitus is often black on account of the acid hematin. This is the so-called "coffee grounds vomitus." Pain is usually very severe after corrosives. Death usually takes place in from 24 to 48 hours, occasionally sooner on account of the shock. The temperature will be elevated if absorption occurs, subnormal, if shock or collapse is produced.

Autopsy. Corrosion or destruction will be found particularly in the upper part of the digestive tract, with alkalies, acids, etc., but in the large intestines from metals. If the action has stopped short of corrosion there will be hyperemia and extravasation of blood. The neighboring abdominal organs may be hyperemic.

Treatment of Poisoning. First dilute the irritant as its action depends upon its concentration. Allow plenty of water or force water upon the animal. If corrosion has started it is dangerous to use the stomach tube on account of the liability of puncturing the stomach. Administer demulcents very freely; mucilage, boiled starch or preteids (white of egg, milk). Administer the chemic antidotes, alkalies for acids and acids for alkalies. Treat the pain and other symptoms as they arise.

Uses. The caustics are occasionally used for counterirritation, but more often for the removal of tissue as in:

1. Bites of venomous animals, snakes, dogs.
2. Removal of pathological tissue: warts, tumors, etc.
3. Indolent granulations.

The most important caustics are:

Hot iron, electricity.

Chemic agents.

Nitric acid on glass rod, for warts, etc.

Trichloracetic acid, on cotton: warts, etc.

Chromium trioxide fused on a probe.

Phenol: infected tissues.
Argenti Nitras, stick: indolent granulations.
Zinci Chloridum, solution: indolent granulations.
Cupri Sulphas, crystals: ulcers of conjunctivitis, etc.
Hydrargyri Nitras.
Plumbi Nitras.
Potassii Hydras, stick: prevent growth of horn.
Calx, paste.
Potassa cum Calce, paste.
Sodii Hydras, stick as in case of caustic potash.

These drugs all have other more important group action and are discussed elsewhere.

Depilatories. These are agents used to remove hair. The most important are barium sulphide and calcium hydrate.

CHAPTER XXI

ALKALIES AND ALKALINE EARTHS

This group is composed of the alkaline salts of potassium, sodium, lithium and certain salts of the alkaline earths, calcium and magnesium. The potassium, sodium and lithium ions are absorbed readily from the gastro-intestinal tract and exert a systemic action following the local action in the stomach. On the other hand, the magnesium and calcium ions are not readily absorbed and exert their action upon the intestines. The magnesium salts tend toward purgation and the calcium toward constipation.

The alkalies may be divided into:

1. *Caustics.* These are the hydroxides of potassium, sodium, and the oxide of calcium. They are all strong irritants, even in weak solution. The caustic action is due to their power of abstracting water from the tissues, saponifying fats, and dissolving albumen. This action has been discussed under the head of escharotics, p. 344.

2. *Those of Milder Action.* These are the carbonates and bicarbonates of potassium, sodium and lithium, and the hydroxides and carbonates of magnesium and calcium.

GROUP ACTION

Antagonists and Incompatibles. Alkalies and their carbonates are incompatible with acids and metallic salts. Ammonium carbonate is incompatible with acid salts and lime water.

External and Local Action. The hydrates of sodium and potassium are rubifacient and caustic according to concentration. Moderate solutions irritate the skin, soften and dissolve the epidermis and horny tissues. The caustic action has been discussed under the head of escharotics, which see p. 344. The carbonates have a similar but weaker action. The bicarbonates, citrates, acetates and bitartrates possess no local action; the ammonium preparations do not correspond with the actions of the above, they penetrate the outer layers of the skin and cause an effusion of serum with vesication and even pustulation if the vapor is confined and in concentration.

Digestive System. Small doses are thought to promote the secretion of gastric juice. Large doses neutralize the free hydrochloric acid in the stomach and by rendering the chyme neutral or

alkaline, interfere with the secretions from the pancreas, liver, and intestines and thereby hinder digestion.

Circulatory System. These agents, by lessening the acidity of the gastric juice, enter the circulation and increase the alkalinity of the blood. The bicarbonate taken in large doses upon an empty stomach enters the blood unchanged, where by decomposing the neutral sodium phosphate present, it forms the acid phosphate, thus increasing the acidity of the blood and urine.

Uses. They are used as antacids, laxatives, antidotes to acid poisons and as astringents.

THE GROUP IN DETAIL

POTASSIUM

The principal effects produced by the potassium ion are depression of the central nervous system and all kinds of muscle including the heart.

The entire central nervous system is affected. The reflexes are first depressed, then the medulla. The heart is said to be stimulated by small doses, fatigued or weakened by medium doses, and paralyzed by large ones. This is due to direct depression of the heart muscle. In poisoning, the heart ceases before respirations stop; the muscles are weakened and their irritability lessened. The above effects are said to be obtained only after intravenous doses according to some writers, while others insist that they may be caused by large doses administered subcutaneously or per os. Animals daily take in large amounts with their food, so that those administered as medicine may be considered as inert. The difficulty in securing toxic action from potassium salts is due to their rapid excretion. The salts of potash are never used in medicine for the action of the potassium ion, since its action on the heart cannot be utilized.

POTASSII HYDROXIDUM

Synonyms. Potassium Hydroxide, Caustic Potash, Potassium Hydrate

Occurs as dry, white translucent pencils or fused masses, odorless or having a feeble odor of lye, and having a very acrid and caustic taste. Deliquescent in air, soluble in 0.9 part of water, 3 of alcohol, and 2.5 of glycerin.

Liquor Potassii — 5 per cent. of potassium hydroxide in water.

Doses. Not often used internally.

Potassii cum Calce. Potassium with lime, Vienna Paste. Greyish white deliquescent powder, containing about equal parts of potassium hydroxide and calcium oxide.

POTASSII CARBONAS

Synonyms. Potassium Carbonate, Sal Tartar, Salts of Tartar

White granular, odorless crystals, slightly alkaline, saline taste, permanent in air, soluble in 3.2 parts of water, almost insoluble in alcohol.

Doses. H. and C. 3ss—j; 2.—4. Dog, gr. v—xx; 0.3—1.3.

Action and Uses. The action and uses have been discussed previously. The hydroxide may be used as a strong caustic to prevent the growth of horn and as an escharotic. Potassium with lime is an escharotic; these preparations are not much used internally. Potassium carbonate is too irritant for internal medication but is added to ointments to aid their penetration by dissolving the grease and sebaceous matter of the skin.

POTASSII CHLORAS — POTASSIUM CHLORATE

This is not really an alkaline salt of potash but on account of difficulty in grouping will be discussed in this place. It occurs in the form of colorless, crystalline plates, odorless and of a cooling, saline taste. It is soluble in 11.5 parts of water, almost insoluble in alcohol. Great care should be used in handling it, as it is liable to explode when heated or subjected to concussion, or trituration with organic substances, sulphur, sulphides, hypophosphates or other easily oxidizable substances.

Doses. H. and C. 3ss—j; 2.—4. Dog, gr. v—xx; 0.3—1.3.

Preparation.

Trochisci Potassii Chloratis, each about 2½ grains.

Action. Applied to mucous membranes it is stimulant or irritant according to concentration. Taken internally, contrary to previous belief, it does not yield oxygen but most of it passes out of the body unchanged. The larger proportion is eliminated by the kidneys, but some is also excreted by the saliva, milk and tears. The only symptom shown after moderate doses, is an increase in the amount of urine. Concentrated solutions, even of therapeutic doses may irritate the stomach and cause nausea and vomiting. For many years the drug was not believed to be toxic but Jacobi in 1861, pointed out the dangers resulting from large doses of the drug.

Symptoms of Poisoning. The symptoms of poisoning by potassium chlorate are the result of the action of the drug upon the heart, gastrointestinal tract, kidneys and blood. Both radicles or ions must be considered; through its potassium ion it depresses the

circulation, and through its acid ion, irritates the stomach, intestines and kidneys, and changes the hemoglobin of the blood to methemoglobin. The first symptoms of poisoning are abdominal pain, thirst, vomiting and purging. Cyanosis is always present and is accompanied by asphyxia and the usual symptoms of heart depression. The urine is scanty, high colored, contains albumen and pigmented tube casts, together with the residue of red cells.

Uses. It is an excellent application in inflammatory affections of the throat and mouth, as in pharyngitis and various forms of stomatitis, and may be used in the strength of 10 to 20 grains to one ounce of water for this purpose. In acute pharyngitis it is frequently useful to add tannic acid or some preparation of tannin to the solution.

It is a specific for ulcerous stomatitis in man, and should be given internally as well as applied externally. For this purpose it can be given in doses of from 3 to 5 grains, well diluted with water, every two hours until the symptoms begin to subside, then less frequently.

SODIUM

The action of the sodium ion is not pronounced. Animals take in large amounts with their food and any excess over the amount required is promptly eliminated. Sollman says, "But when they are retained, these ions (Cl and Na) produce only small actions, for the amounts normally present are so large that the artificial introduction of ordinary amounts will not increase their ratio to any considerable extent."

Sodium salts are less depressant to the circulatory, muscular and nervous systems and less irritant to the gastrointestinal tract than the corresponding salts of potash.

SODII HYDROXIDUM — SODIUM HYDRATE

Synonyms. Sodium Hydroxide, Caustic Soda

Sodium hydrate occurs in white translucent pencils or fused masses, deliquescent, odorless, acrid caustic taste, and of an intensely alkaline reaction. It is soluble in water and alcohol.

Preparation.

Liquor Sodii Hydroxidi — 5 per cent.

These agents resemble the corresponding preparations of potassium and are used for the same purposes as these drugs. They are not used internally.

*SODII CARBONAS — SODIUM CARBONATE

Synonyms. Washing Soda, Sal Soda

Preparations.

**Sodii Carbonas Exsiccatus* — Dried Sodium Carbonate. *Doses.* H. 3ij—vj; 8.—25. D. gr. v—xx; 0.3—1.3.

*Sodii Carbonas Monohydratus — Monohydrated Sodium Carbonate. *Doses.* Same as for the dried carbonate.

Sodium carbonate occurs in colorless crystals; the dried carbonate and monohydrated carbonate as white powders. They are all soluble in water and strongly alkaline. They are antacid but rarely used in medicine. The monohydrated carbonate is specified in the manufacture of glycerin suppositories.

SODII BICARBONAS — SODIUM BICARBONATE

Synonym. Baking Soda.

Sodium bicarbonate occurs as a white, opaque, odorless powder, having a cooling and faintly alkaline taste. It is soluble in 10 parts of water, insoluble in alcohol.

Doses. H. and C. ℥ss—ij; 15.—60. Sh. and Sw. 3j—iv; 4.—15. D. gr. v—xx; 0.3—1.3.

External Action. Sodium bicarbonate in solution is a solvent for dried exudates in mange, eczema, etc. It is sedative to mucous membranes and is a solvent for mucus. In the form of a paste or in solution it is a sedative application for burns, erythema, insect stings and bites.

Gastrointestinal Tract. Sodium bicarbonate neutralizes gastric acidity, whether this is normal or pathological, and dissolves mucus. In neutralizing acids CO_2 is liberated; this is sedative to the part and a stimulant to peristalsis. Thus it relieves pain and aids in the expulsion of gas.

It inhibits salivary, gastric and pancreatic secretion, renders the chyme neutral or alkaline and interferes with digestion. The action of an alkali upon the stomach varies somewhat with the contents of the stomach and time of administration. When given to an empty stomach sodium bicarbonate simply dissolves the mucus and is absorbed into the blood as the bicarbonate, increasing the alkalinity of it. When administered during digestion it interferes with digestion and acts as mentioned above. In this case the CO_2 is liberated and the sodium is absorbed as the chloride.

Uses. *Externally* to relieve minor burns, and to soften or dis-

* Unofficial.

solve exudates; it may be used as a powder or made up into a paste as an application to burns, erythema, bites and stings of insects, etc. To dissolve scabs and exudates it should be used in solution.

Internally. *Antacid.* It is particularly of service in overcoming gastric and intestinal indigestion due to hyperacidity or flatulence. It does not remove the cause, so should always be prescribed with other preparations, such as carminatives, purgatives, etc. It is often prescribed for dogs along with bismuth, salol or beta naphthol, or to horses with gentian and nux vomica. It is also frequently prescribed with calomel as it appears to do away with the disagreeable symptoms following the administration of this agent.

Acidosis. In this case it should be given preferably before meals when the stomach is not acid, but it has an indirect action upon the blood and urine no matter how used. In severe acidosis as in delayed chloroform poison it has been given in large doses by mouth and rectum with only occasional favorable results. The reason for this has not been determined, although it has been attributed to the fact that in diabetes the blood does not become acid while in acidosis due to mineral acids the blood is acid.

In Rheumatism. It should be given until the urine is alkaline. It is of no use in gout.

SODIUM CHLORIDE. SALT

Synonyms. Common or Table Salt, Muriate of Soda, Sal Commune

Source. Mined in the native state, or made from the evaporation of brine, spring or sea water.

Properties. These are well known. Sodium chloride is freely soluble in water and slightly in alcohol.

Preparations.

Liquor Sodii Chloridi Physiologicus — Physiological Salt Solution, normal salt solution — 0.85 per cent. in distilled water.

Doses. Sodii Chloridum, Cathartic. Cow, ℔. ss—j; 250—500. Sheep, ℥j—ij; 30.—60.

External Action. Applied to the skin salt causes some irritation because it abstracts water from the cells. This irritant action is followed by a slight local anesthesia. It is a mild antiseptic and produces its action by withdrawing fluid from the bacteria.

Internal Action. Salt is an essential constituent of food since it is necessary to form the hydrochloric acid of the gastric juice and is abundant in the blood plasma. If animals are fed upon food which is free from salt they die in a short time. Meats contain a considerable amount of salt, but vegetables do not and consequently

herbivorous animals will always seek for it. This accounts for the numerous salt licks of history. Vegetable food not only does not contain salt but robs the body of it in the following manner: The potassium phosphate present in large amounts in vegetable food, reacts in the blood with NaCl to form KCl and Sodium phosphate. Both are rapidly excreted and consequently the salt is lost. This loss could not take place without chemical action because the body holds tenaciously to salt when only the normal amounts are present.

Internally salt may cause gastroenteritis and death if enormous doses are used. The irritation is well marked in the mouth, esophagus, and stomach, so that emesis takes place in vomiting animals. Barlow states that in China, the drinking of a pint or more of a saturated solution in water, is a common method of suicide. The irritant action is due to the withdrawal of water from the tissues. It may serve as a mild cathartic for ruminants but is usually combined with epsom or Glauber's salts for this purpose. Its purgative action may be due in a way at least to the great thirst it creates, so that the animal consumes large quantities of water, which flushes out the system generally. The action of salt is due entirely to mechanical means or to osmosis and is common to all the salts of the alkalies. Small doses may aid digestion.

Uses. Externally — Solutions of salt, ammonium chloride and saltpeter, one ounce of each to the quart of water may serve as a refrigerant but is not to be preferred to applications of cold water or ice.

Internally — Solutions of salt in the strength of physiological salt solution 0.85 per cent. used intravenously are very effective in shock which is due to loss of large quantities of blood or to aid in maintaining blood pressure in shock during or following operations. Physiological salt solution may be of great benefit when injected subcutaneously (hypodermoclysis) or per rectum (proctoclysis). Tap water is to be preferred to distilled water in making physiological salt solution, on account of its calcium salts, which seem to have a beneficial action and are normally present in the blood.

2. Antidote to poisoning by silver nitrate. Salt precipitates the silver in the form of the insoluble chloride.

3. Emetic for dogs. One or two drams of salt to the cup of tepid water, either administered alone or combined with two ounces of mustard may serve as an emetic in cases of emergency.

4. Salt may advantageously be added to the usual saline purge for ruminants, because it induces the consumption of large quantities of water, which in itself assists in the action of salines.

5. Enema for oxyures or pin worms. It should be made into a solution in the proportion of one-half to one ounce of salt in a pint of water and injected into the previously emptied rectum.

SODII PHOSPHAS — SODIUM PHOSPHATE

Sodium phosphate occurs as large colorless, monoclinic prisms, odorless, and possessing a cool saline taste. It gradually effloresces in dry air and loses 5 molecules of water of crystallization. (One gram dissolves in 2.7 mils of water; insoluble in alcohol.)

Doses. Same as for the sulphate.

Action and Uses. The action is the same as that of the sulphate but milder. It is indicated in jaundice due to duodenitis and as a laxative for foals and calves. It has been recommended as a source of phosphorus in rickets, but the calcium salt is to be preferred.

Sodium borate and perborate are discussed under antiseptics.

LITHIUM

Lithium has a potassium-like action upon the heart and voluntary muscles, but to a lesser degree. Large doses cause nausea, vomiting, diarrhea and gastroenteritis, followed by emaciation and death. This results whether the drug is administered per os or hypodermically; in the latter case through its elimination by the intestines. It is excreted principally by the kidneys, but to a smaller extent by the saliva, stomach and bowels. It increases the amount of urine by its salt action and does not irritate the kidneys. Like the other fixed alkalies, lithium salts render the urine alkaline. Materia Medica of lithium salts is given under diuretics, p. 298.

CALCIUM

Calcium salts are present in the bone and hard parts of the body and also in the blood and soft tissues. It is a necessary constituent of all protoplasm and is necessary for the action of certain ferments.

Action. *Bones.* When calcium salts are withheld from the food of growing animals, symptoms resembling rachitis and osteomalacia are seen, but differ in calcium starvation from those of the previously mentioned diseases, because although little bone is formed it contains the normal proportion of calcium. This has led to the use of calcium in the treatment of these diseases, but it appears that in these conditions there is an inability to use what calcium is in the food and many cases do not respond to the administration of calcium. Most of the calcium is taken into the body in drinking water and vegetables. Animal matter, with the exception of bones, contains but little calcium.

Specific Action. Calcium has a specific action on all forms of muscle similar but weaker than barium. It increases the contrac-

tion and prolongs the period of relaxation of muscle, constricts the bloodvessels and increases the rhythm and force of the heart beat. These effects are antagonized by potassium and magnesium and vice versa.

One of the most important specific actions of calcium is its power to retard or prevent inflammation. For instance, a calcium salt injected subcutaneously will prevent the reaction from the application of mustard, probably on account of a lessened permeability of the bloodvessels. Normal dogs are resistant to the experimental production of moist eczema, but if the calcium in the circulation is precipitated by the injection of oxalates, the resistance is reduced. This has suggested the use of calcium in the treatment of moist eczema and urticaria and to prevent rashes following the use of serum. It is not known how this action is brought about.

Nervous System. Calcium salts favor the normal reaction of nerve tissue. Cushing demonstrated that the sensitiveness of motor nerve endings which have been depressed by normal saline, regain their sensitiveness by perfusion of normal amounts of calcium in the saline solution.

Absorption and Elimination. Calcium salts are absorbed to a small extent from the stomach and intestines. Absorption is facilitated by the presence of fats which form calcium soaps. Most of the absorbed salt is excreted into the intestine but some escapes by the urine. The percentage eliminated by the urine is increased during calcium starvation and is more during rest than in exercise. The percentage in the blood is not influenced by oral doses to normal animals.

CALCIUM

Metallic calcium is not used in medicine.

CRETA PREPARATA — PREPARED CHALK

Synonym. Drop Chalk

Prepared chalk is a white amorphous powder, often moulded into cones, odorless, tasteless, permanent in the air, almost insoluble in water, insoluble in alcohol.

Incompatibilities — Acids and sulphates.

Preparations and Doses.

Creta Preparata. H. ℥j—ij; 30.—60. D. gr. x—℥j; 0.65—4.0.

Pulvis Cretæ Compositus. Compound Chalk Powder, chalk 30, Acacia 20, sugar of milk 50. *Dose.* Same as for the above.

Mistura Cretæ. Chalk Mixture. Compound chalk powder

200, Cinnamon water 400, water to make 1000. *Dose.* Dog, ℥j—ij; 30.—60.0.

Calcii Carbonas Præcipitatus. Precipitated Calcium Carbonate. Precipitated chalk.

Precipitated chalk occurs as a fine white odorless and tasteless powder. It is permanent in air, sparingly soluble in water, insoluble in alcohol.

Doses. H. ℥j—ij; 30.0—60.0. Dog, gr. x—lx; 0.65—4.

Action and Uses. Externally and locally chalk is a desiccant, feeble astringent and protective.

Internally. Since chalk is not easily dissolved, it is a very feeble and slow acting antacid, but is nevertheless useful when a slow, continuous action is desired. It is protective to the gastro-intestinal mucous membrane and resembles the action of the bismuth salts in mechanically coating and protecting the irritated or inflamed mucous membrane. On account of its cohesive tendency, prepared chalk is to be preferred to the precipitated variety for internal use. Chalk is less astringent and antiseptic than the various salts of bismuth, so that these salts are preferred for use in small animal practice.

Administration. Chalk may be administered to horses and cattle as a powder, in pill, capsule, or shake mixture in mucilage. One of the official preparations is preferred for dogs.

CALX — LIME

Synonyms. Burned Lime, Quick Lime

Lime occurs as hard white or grayish masses, which in contact with air gradually draw moisture and CO_2, and fall down as a white powder. Lime is odorless, of a caustic taste, alkaline reaction, soluble in 750 parts of water, insoluble in alcohol.

Preparations.

Liquor Calcis. Lime water. This is a saturated aqueous solution of lime prepared by dissolving lime in water. The chlorides are removed by first slaking the lime with a small amount of water, which is discarded. More water is then added. *Doses.* H. ℥iv—vj; 120.—180. Dog, ʒj—viij; 4.0—30.0.

**Syrupus Calcis.* Syrup of lime. Lime 65, sugar 400, water to make 1000. *Doses.* Dog, ʒss—j; 2—4.

Linimentum Calcis. Carron Oil. Lime water and linseed oil, equal parts.

Calcii Hydras. Slaked Lime. Not used internally.

* Unofficial.

Action. *Externally and locally.* Lime is irritant and caustic, but less so than sodium and potassium hydrates. The hydrate is less caustic than lime.

Internally. Lime is used only in the form of some of its official preparations. Its action is due to the hydroxyl ion instead of the calcium. In solution it is a sedative, antacid, slightly astringent, and like other alkalies assists in the solution of mucus.

Uses. *Externally.* Lime is commonly used as a disinfectant and deodorant for cess polls, where a cheap agent is required. It produces its action by combining with water to form slaked lime. Ordinary whitewash is not antiseptic in the strict sense of the word, although it may cover up infection, but may be made antiseptic by the addition of sufficient quantities of crude phenol or other disinfectant.

Slaked lime may be used as an antiseptic, desiccant, and absorbent powder for wounds either when used alone or in combination with equal parts of charcoal. Enemata of lime water are often serviceable for the removal of oxyures or pin worms.

Carron oil is a very good dressing for superficial burns, but should be rendered antiseptic with phenol or other antiseptic. It should be kept upon the burned surface by means of soft cloths which have been saturated with it.

Internally. Lime water is sedative to the stomach and will often relieve the vomiting of gastritis of dogs and cats. It is often mixed with the milk for animals which are brought up artificially to dilute it and to diminish the size of the curds formed in the stomach. Lime water and carron oil often prove of service in heaves of horses. The former may be sprinkled upon hay or given in water while the latter may be given upon grain. Carron oil is a useful laxative for small or young animals.

CALCII SULPHAS EXSICCATUS

Synonyms. Plaster Paris, Dried Calcium Sulphate

Plaster of Paris is used only in the preparation of fixation bandages. It is not used internally.

BARIUM

Metallic barium is not used in medicine.

BARII CHLORIDUM — BARIUM CHLORIDE

Barium chloride occurs in colorless glistening rhombic plates; bitter and disagreeable taste; permanent in air; soluble in 2.5 parts of water.

Dose. H. 3ij—iv; 8.—15. Intravenously, gr. vij—xv; 0.5—1.

Action and Uses. Barium is a strong irritant, having a special affinity for all forms of muscle. As soon as a muscle comes into contact with barium it goes into tonic contraction. When taken per os it causes colicky pains, nausea, vomiting and increases peristalsis due to the action of the drug upon the muscle of the intestines. Death is caused by central nervous paralysis and is preceded by strong tonic and clonic convulsions. Sodium sulphate is said to be the best antidote.

Muscle. Barium has an action on voluntary muscle like that of veratrine. Plain muscle generally goes into contraction. The muscle of the intestines contracts in rings or bands which relax

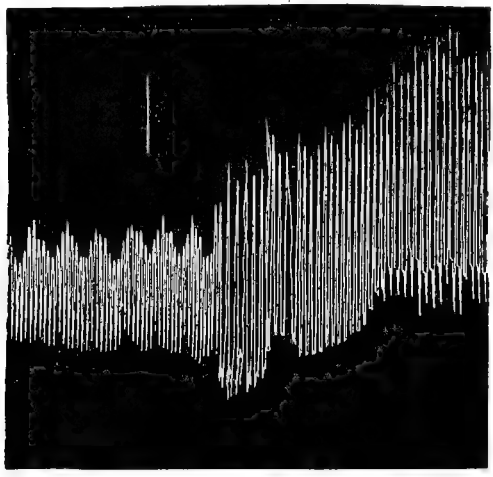

FIG. 21.

Blood pressure tracing. Horse. Normal pressure tracing at the left. Effect of Barium Chloride at the right. The vertical line above the tracing indicates the point at which the injection was made. (Tracing made by Dr. P. A. Fish.)

slowly and are followed by others. Other plain muscles also contract. The bloodvessels are constricted causing a great and persistent increase in blood pressure. Cardiac muscle is affected in the same manner as other muscle. Barium resembles the action of a digitalis on the heart but differs from digitalis in increasing the rate.

Therapeutics. The only indication for the use of barium is as a purgative for the horse. See purgatives, p. 257. Its digitalis-like action or action on the heart cannot be utilized on account of its dangerous side actions. Barium should not be administered subcutaneously because it will cause abscess at the site of injection.

MAGNESIUM

When salts of magnesium are taken or administered per os, they serve as purgatives because they are absorbed with difficulty. The purgative action has been discussed under the salines. If the salts are injected intravenously or subcutaneously in sufficient amounts they depress the nervous system and cause complete narcosis and relaxation of the muscles. This action is now being utilized in the treatment of tetanus with reported success. A complete and rapid recovery from the action of magnesium salts may be brought about by the intravenous injection of calcium.

MAGNESII CARBONAS — MAGNESIUM CARBONATE

Magnesium carbonate occurs as light, white, friable masses (Heavy magnesia [B. P.]) or light white powder (Light magnesia B. P.). It is odorless, of a slightly earthy taste, permanent in air, almost insoluble in water, insoluble in alcohol.

Doses. Foals and Calves 3 j—ij; 4.0—8.0. Dogs gr. v—ix; 0.3—4.

MAGNESIUM OXIDUM — MAGNESIUM OXIDE

Synonyms.—Magnesia, Light Magnesia, Calcined Magnesia, Burnt Magnesia

Magnesium carbonate occurs as a white, very light, odorless powder, having an earthy taste, almost insoluble in water, insoluble in alcohol, but soluble in dilute acids. One part of the salt on being mixed with 15 parts of water and allowed to stand for half an hour, hydrates and forms a gelatinous mass.

Doses. The same as for the carbonate.

MAGNESII OXIDUM PONDEROSUM — HEAVY MAGNESIUM OXIDE

Synonyms. Heavy Magnesia, Heavy Calcined Magnesia

Heavy magnesia is a white, dense, fine powder differing from the light variety only in not forming a gelatinous mass with water.

Doses. The same as for the carbonate.

Preparations of Magnesia. * *Pulvis Rhei Compositus* (65 per cent.).

Ferri Hydroxidum cum Magnesii Oxido.
Magma Magnesii. Milk of magnesia.

Action and Uses of Magnesia. The salts of magnesium are weak alkalies without caustic action. They are partly converted

* Unofficial.

into soluble salts in the stomach and exert a purgative action which has been discussed previously. Magnesia is often useful in indigestion of young animals with tympany and diarrhea. It may be given in the form of the compound rhubarb powder or with equal parts of rhubarb and magnesia and half as much ginger. Besides its antacid and laxative action, magnesium enters into the well known arsenic antidote — Ferri Hydroxidum cum Magnesii Oxido. Magnesium should not be given over a long period of time as it is said to be liable to cause intestinal concretions.

AMMONIA AND AMMONIUM

The action of ammonium and its salts differs exceedingly from the previously discussed alkalies. Externally the solutions of *ammonia* and the gas are very irritant but they are not so corrosive as the hydrates of the other alkalies.

The characteristic action of the ammonium ion when given subcutaneously or intratracheally is stimulation of the central nervous system which is followed by depression after large doses. Reflex irritability is increased and convulsions may take place. The heart and respirations are stimulated reflexly due to the irritant action of the drug. The ammonium ion also increases the secretions, especially the saliva, mucus and sweat. The diaphoretic action is believed to be of central origin while the action on saliva and mucus may be accounted for by: 1. Reflex stimulation of the *mucosæ* due to irritation of the mucous membrane of the mouth. This action is important on account of the fact that the salts of ammonium are somewhat eliminated by the saliva into the mouth and thus produce their local action a second time. 2. Direct stimulation of the secretory center.

AMMONIA

This is a colorless gas, very pungent in odor, and possessing an acrid taste. It is obtained as a by-product in the manufacture of coal gas. It is only used in solution.

Preparations.

Aqua Ammoniæ. Ammonia Water.

Ammonia water is a solution containing not less than 9.5 per cent. nor more than 10.5 per cent. of ammonia in water.

Doses. H. ℥ j—iv; 4.—16. D. ♏ ij—xv; 0.13—1.

Aqua Ammoniæ Fortior. Stronger Ammonia Water.

Stronger ammonia water is an aqueous solution of ammonia which should contain not less than 27 nor more than 29 per cent. of ammonia.

Doses. One half those of Aqua Ammoniæ.

* *Spiritus Ammoniæ. Spirits of Ammonia.*

Spirits of ammonia is an alcoholic solution containing 10 per cent. of ammonia.

Spiritus Ammoniæ Aromaticus. Aromatic Spirits of Ammonia consists of ammonia water 90 mils, ammonium carbonate 34 grams, alcohol 700 mils, essential oils and water to make 1000 mils.

Doses. H. ʒ ss—iij; 15.—90. D. ♏ v—lx; 0.3—4.

Linimentum Ammoniæ, Ammonia Liniment. Ammonia water 250, sesame oil 750.

External Action. Ammonia is a powerful irritant to the skin but differs from the fixed alkalies in not being corrosive or persistent in action. Furthermore it does not dissolve the epidermis but passes through it and forms blisters. On account of this action it is often used as a counterirritant.

Digestive System. Like other alkalies, ammonia serves to neutralize any free acid that may be in the stomach and in dilute solution is carminative.

Circulatory System. Ammonia produces a transient elevation of blood pressure when inhaled or administered per os due entirely to reflex stimulation of the heart and vasomotor center through irritation of the gastric or nasal mucous membranes. The blood pressure is also raised if the drug is injected subcutaneously in moderate doses but in this case there is probably some direct action upon the vasomotor center as well as reflex action.

Sometimes a temporary slowing of the heart is observed due to stimulation of the vagus center.

Respiratory System. Moderate doses increase the depth and volume of the respirations by reflex stimulation of the respiratory center. This action is very marked when the drug is inhaled.

Excretion. Ammonia undergoes very rapid changes in the body and is consequently very transient in action. It differs from the fixed alkalies in not adding to the alkalinity of the tissues because it is transformed into urea soon after its absorption and is eliminated as such.

Therapeutics. Ammonia is employed as a rapid acting cardiac and respiratory stimulant, as an antacid, carminative and counterirritant.

It is a valuable stimulant in shock and other sudden heart or respiratory failures. It may be given by inhalation, hypodermatic injection, intratracheally or per os.

It is very useful as an antacid and carminative in various forms

* Unofficial.

of indigestions and colic. It is usually administered in the form of aromatic spirits of ammonia well diluted for this action.

It is a valuable rubifacient for sprains, rheumatism, etc., and enters into many liniments used for this purpose.

AMMONII CARBONAS — AMMONIUM CARBONATE

Carbonate of ammonia occurs in the form of white, transparent crystalline masses, having an extremely pungent odor and acrid taste. Upon exposure to air it breaks up into a white powder, bicarbonate of ammonium. Only translucent pieces should be used. Ammonium carbonate may also be purchased in cubes which are said to keep much better than the other forms. It is soluble in water.

Doses. H. 3 ijss—vj; 10.—25. D. gr. iij—xv; 0.2—1.

Ammonium carbonate acts similarly to ammonia and may be used in the same conditions internally. It stimulates the secretion of the gastric juice, increases the blood supply to the stomach and is an antacid. It is therefore a carminative, stomachic, and antacid in addition to being a reflex circulatory and respiratory stimulant. It is eliminated by the mucosæ generally and particularly by that of the respiratory tract and is consequently a stimulating expectorant. Furthermore on account of its alkaline action it aids in liquefying the secretions and assists in their removal.

SPIRITUS AMMONIÆ AROMATICUS

The ingredients of this preparation have been given previously. It resembles ammonium carbonate in action although the alcohol and oils add somewhat to its effects.

Therapeutics. The uses of these two preparations are in general the same as for other preparations of ammonium. The carbonate is more useful as an expectorant while the carbonate or aromatic spirits of ammonia is more serviceable as a carminative than ammonia water. Ammonium carbonate is a valuable respiratory and circulatory stimulant and may be given in capsules or as the aromatic spirits of ammonia. Reek recommends it in the treatment of colic. He directs that one ounce of ammonium carbonate and one ounce of powdered nux vomica be given in four capsules to a large horse. The ammonium salt may be repeated if the case demands it. Either of these preparations are valuable carminatives in various indigestions.

Carbonate of ammonia is an emetic and expectorant. For the latter purpose it is especially useful in the secondary stage of diseases of the respiratory tract.

Administration. The carbonate should be given in pill, cap-

sule, in solution in cold water or in mucilaginous drinks to avoid its irritant action. Aromatic spirits of ammonia should be given in capsule, or in water or oil. They are frequently combined with camphor, capsicum, ginger, antispasmodics or other stimulants. Since they produce action very quickly, it is necessary to repeat them at short intervals to continue their stimulating effects.

AMMONII CHLORIDUM — AMMONIUM CHLORIDE

Synonyms. Sal Ammoniac, Muriate of Ammonia

Ammonium chloride occurs as a white crystalline powder, without odor and having a cooling saline taste. It is permanent in air, very soluble in water, insoluble in alcohol.

Doses. H. ℥ j—iv; 4.—15. D. gr. ij—x; 0.13—0.6.

Action. Ammonium chloride is a very feeble heart and respiratory stimulant and not nearly so effective as the carbonate. It is eliminated like the other ammonium preparations and like them stimulates the mucosæ through which it is excreted and increases their secretions. It is eliminated to some extent through the bronchial mucous membrane increasing and thinning the secretion. It is a refrigerant externally.

Therapeutics. Ammonium chloride is chiefly used as an expectorant, especially in the second stage of acute bronchitis or in chronic bronchitis. It is frequently combined with heroine or codeine if cough is severe. It is used externally in solution in water as a refrigerant.

LIQUOR AMMONII ACETATIS — SOLUTION OF AMMONIUM ACETATE

Synonym. Spirit of Mindererus

This is an aqueous solution of ammonium acetate containing 7 per cent. of the salt together with small amounts of acetic acid and carbon dioxide. It is prepared by gradually adding ammonium carbonate to cold diluted acetic acid until the latter is neutralized. It is a clear colorless liquid without odor and of a saline acidulous taste.

Doses. H. ℨ ij—iv; 60.—120. D. ℥ ij—iv; 8.—15.

Action and Uses. Solution of ammonium acetate is a mild diuretic, diaphoretic and antipyretic. It is a very feeble remedy and is often used as a vehicle for stronger agents with a similar action. It is frequently combined with spirits of nitrous ether as a febrifuge in the early stages of respiratory diseases.

CHAPTER XXII

ACIDS

The acids included in this group are those inorganic and organic acids which act by virtue of their H ion and not in a specific manner, as in case of hydrocyanic, salicylic and arsenous acids. Since the action of all the acids of this group is quite similar, they will be discussed together. The action of acids may be described as local and remote. The local action consists of corrosion, when in concentration (see caustics) while weaker solutions convert the proteids of the tissues into acid albuminates. Acids produce by local action: changes in either living or dead matter and destruction of body tissues in concentrated solutions.

By a remote action they: 1. Exert a peculiar ion action in dilute solution due to the H ion.

2. Modify digestion by action upon the digestive ferments.

3. They produce changes by osmosis or salt action like any absorbable salt since they are converted into salts before absorption.

Actions. Externally they are irritant or caustic according to concentration. See Caustics.

Internally. *Dilute acids.* All acids have a sour taste and are somewhat astringent. They reflexly stimulate the secretion of saliva, gastric and pancreatic juice. If any free acid reaches the intestines, it serves as an irritant and stimulates peristalsis. Most acids, however, are absorbed or converted into salts before reaching the intestine so that the purgative action is rarely seen.

Urine. Acids are strong diuretics, due in part to salt action and in part to the action of the H ion. The urine will become more acid not on account of the presence of acids but to acid salts. The acid urine leads to inflammation of the mucous membrane of the urinary tract, on account of which acids should be avoided in inflammatory conditions of these passages.

Toxicology. The corrosive action has been discussed under the head of caustics so will not be repeated. Besides the corrosive form of poisoning, herbivora become affected with the so-called "acid intoxication" which is due to a diminished alkalinity of the blood caused by the combination of the absorbed acids with the fixed alkali and excretion of the resultant compound. In this manner as the alkali decreases, less and less CO_2 is absorbed from the tissues and

on account of the diminished internal respiration, the animal dies from asphyxia before the blood becomes even neutral in reaction.

The symptoms of acid intoxication are: gasping for breath, followed by short shallow respirations until they cease entirely. The heart grows progressively weaker and consciousness is lost. This form of intoxication is not seen in man or dogs and is best explained by the theory that they have a protective mechanism against this form of poisoning. Carnivora and omnivora consume a considerable amount of meat which causes the formation of acids. On the other hand, since they do not consume large quantities of alkaline salts in their food, their bodies easily form the alkaline ammonia which neutralizes the acids injested or produced in their metabolism. The carnivora excrete the acids mainly in the form of ammonium compounds, and the increase in the ammonia is at the expense of the urea which is correspondingly diminished.

Acid intoxication may, however, be produced in carnivora, either by subcutaneous or intravenous injections of amounts greater than the body can take care of. In man a typical acid intoxication is seen at the end of diabetic coma. In this condition oxybutyric and diacetic acids are formed so rapidly that the protective phenomena are unable to neutralize them, although large amounts of ammonia are found in the blood and urine.

Treatment. This is not very promising. Sodium bicarbonate should be administered in large doses per os or per rectum. Maintain the circulatory and respiratory systems with stimulants.

Elimination. Acids are excreted by the kidneys of herbivora as the salts of potassium, from the carnivora as the salts of ammonium. Since the body endeavors to retain all the alkali possible, it throws them out as acid salts and occasionally as free acids. These may cause irritation as stated previously.

The organic acids as acetic, citric, lactic and tartaric are absorbed as the salts of the alkalies and are oxidized in their passage through the body, to carbonates and excreted as such by the kidneys, so that they do not lessen the alkalinity of the blood after internal administration, nor render the urine more acid.

Therapeutics.

1. Caustics and escharotics.
2. In dyspepsia due to diminished secretion of hydrochloric acid. Hydrochloric or nitrohydrochloric acids are to be preferred for this action and act best when administered with bitters. They are contraindicated in conditions with hypersecretion of mucus.
3. Antidotes to poisoning by alkalies.
4. They are useful in fevers in human medicine to allay thirst and serve as mild diuretics. This is of but little importance to veterinarians.

THE GROUP IN DETAIL

ACIDUM HYDROCHLORICUM — HYDROCHLORIC ACID

Synonyms. Muriatic Acid, Spirit of Salt

This is an aqueous solution containing not less than 31 nor more than 33 per cent. of hydrochloric acid. It is prepared by heating sodium chloride and sulphuric acid, and dissolving the gaseous hydrochloric acid thus obtained in water. It occurs as a colorless, fuming liquid, having a pungent odor and strong acid taste. It fumes when exposed to ammonia vapor or the air due to the formation of ammonium chloride. The fumes and odor disappear on diluting with two volumes of water. The ordinary commercial variety (strength 30–33 per cent.) has a golden yellow color due to the presence of iron and free chlorine. It also frequently contains arsenic and is therefore unsuitable for medical purposes.

Preparation. *Acidum Hydrochloricum Dilutum* — Diluted hydrochloric acid. 9.5—10.5 per cent.

Doses. H. ℥ j—ij; 4.—8. D. ♏ x—xxx; 0.6—2.

ACIDUM NITRICUM — NITRIC ACID

Nitric acid U. S. P. contains not less than 67 per cent. nor more than 69 per cent. of absolute nitric acid. It occurs as a colorless liquid but assumes a yellow color and emits fumes of hyponitrous acid upon exposure to air. It stains organic matter yellow.

Preparation.

* *Acidum Nitricum Dilutum.* Diluted Nitric Acid. An aqueous solution containing not less than 9.5 per cent. nor more than 10.5 per cent. of absolute Nitric acid.

Doses. H. ℥ j—iv; 4.—15. D. ♏ iij—xv; 0.18—1.

ACIDUM NITROHYDROCHLORICUM — NITROHYDROCHLORIC ACID

Synonyms. Nitromuriatic Acid, Aqua Regia

This is prepared by mixing 18 mils of nitric acid with 82 mils of hydrochloric acid in an open vessel and allowing the mixture to effervesce.

Preparation.

Acidum Nitrohydrochloricum Dilutum. Diluted nitrohydrochloric acid is prepared by mixing 10 mils of nitric acid, 45.5 mils of hydrochloric acid and 194.5 mils of distilled water.

Doses. H. ℥ i—ij; 4—8. D. ♏ iij—xv; 0.18—1.

* Unofficial.

It has been claimed by some that this acid is a hepatic stimulant but it is generally believed to exert nothing more than an acid action.

ACIDUM PHOSPHORICUM — PHOSPHORIC ACID

Phosphoric acid U. S. P. is a colorless liquid containing not less than 85 per cent. nor more than 88 per cent. of phosphoric acid. It is prepared by burning phosphorus, dissolving the resulting oxides in water and completing the oxidation with nitric acid.

Preparation. *Acidum Phosphoricum Dilutum.* Diluted phosphoric acid. Not less than 9.5 per cent. nor more than 10.5 per cent. by weight of phosphoric acid.

Doses. H. ʒ j—iv; 4—15. D. ♏ iij—xxx; 0.18—2.

Phosphoric acid is held by some to be less injurious to digestion than the others but this is doubtful.

ACIDUM SULPHURICUM — SULPHURIC ACID

Synonyms. Oil of Vitriol, Vitriol

This is a colorless, syrupy fluid containing not less than 93 per cent. nor more than 95 per cent. of sulphuric acid. It acquires a brownish color if exposed to dust. It is miscible in all proportions with alcohol and water but the mixing evolves much heat and must be done carefully, and by pouring the acid gradually into the water or alcohol and constantly stirring the mixture. It is prepared on a large scale by burning pyrites or native sulphur. The SO_2 fumes are oxidized by means of nitrous fumes produced by the action of concentrated sulphuric acid on Chili saltpeter. The product is condensed in a system of lead chambers, in the presence of steam, and concentrated first in lead pans, and then distilled from glass or platinum retorts. The commercial variety contains arsenic and consequently must be avoided in internal medicine. Sulphuric acid is very corrosive and chars organic material.

Preparations. *Acidum Sulphuricum Dilutum.* Diluted Sulphuric acid. Not less than 9.5 per cent. nor more than 10.5 per cent. of sulphuric acid.

Doses. H. ʒ ij—vj; 8—24. D. ♏ v—xv; 0.33—2.

Acidum Sulphuricum Aromaticum. Aromatic Sulphuric Acid contains about 20 per cent. of sulphur acid, alcohol, tincture of Gentian and oil of cinnamon. *Doses.* Half those of the diluted acid. It is doubtful if this preparation has any advantages over the preceding.

Action and Uses. Sulphuric acid is not often used in medicine.

ACIDUM SULPHUROSUM — SULPHUROUS ACID

This is a solution containing at least 6 per cent. of sulphur dioxide. Dose. H. ℥ ij—viij; 8—30. D. ♏ v—xv; 0.33—1. It is prepared by allowing sulphuric acid to act upon charcoal, the resulting sulphur dioxide being dissolved in water. It should be kept well corked in amber bottles.

Action and Uses. It is used as a disinfectant and parasiticide in skin diseases and for gastric fermentation. This acid is also formed by burning sulphur in the presence of moisture and is used in this manner as a favorite method of fumigating stables, etc.

ACIDUM ACETICUM — ACETIC ACID

Acetic acid is a liquid containing from 36 to 37 per cent. by weight of absolute acetic acid. It corresponds very closely to the #8 of commerce. It occurs as a clear colorless liquid, of strongly characteristic vinegar-like odor and sharply acid taste.

Preparations. *Acidum Aceticum Glaciale.*

Glacial Acetic acid contains 99 per cent. by weight of absolute acetic acid.

Acidum Aceticum Dilutum. Diluted acetic acid must contain not less than 5.7 per cent. nor more than 6.3 per cent. of absolute acetic acid.

Doses. H. ℥ j—ij; 30.—60. D. ℥ ss—j; 2.—4.

Action and Uses.

1. Glacial acetic acid is used as a caustic to remove warts.

* ACIDUM PYROLIGNOSUM — PYROLIGNEOUS ACID

Synonym. Wood Vinegar

This is prepared by the destructive distillation of wood. It contains from 5 to 7 per cent. of acetic acid, some methyl alcohol, acetone and tar.

Action and Uses. Used externally to combine the effects of acetic acid and tar.

Acetum. Vinegar is an impure form of diluted acetic acid containing from 4 to 7 per cent. of acetic acid prepared by the fermentation of cider or wine.

ACIDUM CITRICUM — CITRIC ACID

Properties. Colorless translucent crystals or white powder, odorless acid taste, efflorescent in warm air.

Citric acid is widely distributed throughout the vegetable king-

* Unofficial.

dom. It occurs either free or in combination with potassium, calcium or magnesium. It is present in large amounts in all acid fruits and usually occurs with malonic, tartaric or other organic acids. It is prepared by allowing lemon juice to ferment during which process the gummy matter is precipitated. The proteids are removed by boiling and the filtered juice treated with chalk, forming calcium citrate. This is then decomposed by sulphuric acid and the citric acid separated by crystallization. It is soluble in 0.54 of water, in 1.55 of alcohol. It is not used except as the vegetable salts of the alkalies.

ACIDUM TARTARICUM — TARTARIC ACID

This is a dibasic organic acid usually obtained from wine lees or argol. It occurs as colorless translucent, monoclinic prisms, or as a white granular or fine powder; odorless, having an acid taste; permanent in dry air. Soluble in 0.75 part of water and 3.3 of alcohol.

It is not used in veterinary medicine.

ACIDUM TRICHLORACETICUM

Trichloracetic acid is prepared through the oxidation of chloral. It occurs as colorless, deliquescent, rhombohedral crystals, of a slightly characteristic odor. It is soluble in water, alcohol and ether. It is used as a caustic for warts. Is less painful than nitric acid.

ACIDUM LACTICUM — LACTIC ACID

Lactic Acid is prepared by subjecting invert sugar to lactic fermentation in the presence of zinc oxide. The zinc lactate so formed is then decomposed by hydrogen sulphide, and the filtered solution evaporated to the desired amount. It occurs as a syrupy, colorless, odorless liquid with an intensely acid taste. It is miscible with alcohol, water or ether. Externally, it is a caustic. It has no internal indications.

ACIDUM OXALICUM — OXALIC ACID

Oxalic Acid is prepared by the action of nitric acid upon sugar or starch or by fusing sawdust with a mixture of sodium and potassium hydroxides. It is purified by recrystallization. It occurs as small colorless crystals, soluble in 10 parts of water, 2.5 parts of alcohol.

Uses. Oxalic acid is a caustic but is not often used on account of its dangerous action following absorption. It has little real value in medicine but may be used to remove stains of potassium permanganate.

ACIDUM STEARICUM — STEARIC ACID

This is prepared by the decomposition of fats, especially tallow with acid, either directly or after previous saponification, and separating the liquid portion, oleic acid, by expression. It occurs as a hard, white, odorless, tasteless solid, soluble in alcohol and ether, melting at a temperature not lower than 56° C. It is used to give consistency to ointments and cerates.

ACIDUM OLEICUM — OLEIC ACID

The preparation of this acid has been described under stearic acid. It occurs as a yellow oily fluid, of lard like odor and taste. It is insoluble in water, soluble in alcohol, ether and fat solvents. It is used pharmaceutically in the preparation of plaster, ointments, soaps and liniments.

CHAPTER XXIII

GROUP OF HALOIDS OR HALOGENS

This group comprises the free halogens: chlorine, bromine, iodine and those compounds of these elements from which they are easily liberated in the free state. The free halogens are all irritants and corrosives. This action is brought about by their entering very easily into chemical combination with all organic matter, by withdrawing hydrogen from it and forming hydrochloric, hydrobromic and hydriotic acids, which exert the usual acid actions. Furthermore by breaking up the water of the tissues they will set free ozone, which is also irritant. This explains the irritant, corrosive and antiseptic action of the haloids.

The above actions are most marked with chlorine, less so with bromine, and least of all with iodine. If chlorine is kept in contact with the skin there is a severe destruction of tissue. Bromine, however, has almost as severe an action and by some authorities is given first place over chlorine. Being at the same time a liquid, and volatile, it can remain for a longer time in contact with the skin, and penetrates very deeply, producing marked destruction of tissues and slow healing ulcers. The action of iodine is much less violent and will be discussed in detail later.

Both chlorine and bromine are very irritant to the mucous membrane of the respiratory tract and may cause bronchitis or inflammation and edema of the lungs. One part of bromine to a million is said to be disagreeable while ten parts to a million are dangerous. When the halogens are taken internally in sufficient quantities, death takes place from gastroenteritis and collapse. The symptoms are severe pain in the throat, esophagus and abdomen, together with bloody vomiting and purging. If the quantity ingested is not sufficient to produce death, ulcers are found at the points of contact, especially in the stomach and esophagus. If these ulcers do not perforate and cause death they heal by cicatricial formation which may produce stenosis of the esophagus. The chemical antidote for chlorine and bromine is albumen; for iodine, it is starch. Their toxic action is purely local.

BROMUM — BROMINE

This is a nonmetallic element obtained from sea water. It is a dark, reddish brown liquid, evolving, even at normal temperatures,

irritating and suffocating fumes; soluble in 28 parts of water, also soluble in alcohol and ether.

Action and Uses. It is an escharotic, caustic, irritant, disinfectant and deodorant as mentioned previously. It has been employed as an escharotic for cancerous growths but has been practically discarded.

Principal salts are the bromides which have been discussed previously. See page 155.

CHLORUM — CHLORINE

This is a heavy, yellowish green gas, with a suffocating odor and caustic taste. It may be prepared by heating together sodium chloride, sulphuric acid and manganese dioxide, or by the action of an acid upon chlorinated lime.

Preparations. * *Liquor Chlori Compositus.* Contains at least 4 per cent. of gas with some oxides of chlorine and potassium chloride.

Doses. Not used internally.

Action and Uses. The actions are same as for chlorine but it is used more as a disinfectant and deodorant. It is particularly serviceable as a disinfectant for cesspools, animal discharges, etc., but not for rooms and stables since it is so exceedingly irritant, and besides it is so heavy that it does not diffuse readily. The solution is very unstable, but has been used as a wash for fetid sores and as an intestinal antiseptic. Its use has largely been discontinued.

CALX CHLORINATA — CHLORINATED LIME

Synonym. Bleaching Powder (improperly called chloride of lime)

Chlorinated lime is made by passing chlorine over slaked lime and should contain not less than 30 per cent. of available chlorine. It consists principally of hypochlorite and chloride of calcium and occurs as a grayish white powder, with strong chlorine odor and disagreeable saline taste. Slightly soluble in water and alcohol.

Action and Uses. Always as a disinfectant and deodorant. Solutions of from ½ to 1 per cent. kill most bacteria in ten minutes. One half per cent. solution of freshly prepared chlorinated lime makes an excellent solution for disinfecting walls and clothes. A 1 per cent. solution is useful to disinfect animal discharges.

Dakin's Antiseptic. Dakin devised a carefully standardized neutral solution of the hypochlorites which has given excellent results as an antiseptic in the European war. Carrel, in the *Journal of the American Medical Association,* December 9, 1916, gives the following directions for its preparation. The solution must be free from alkali hydroxide, and the concentration of the sodium hypochlorite

* Unofficial.

must be exactly between 0.45 and 0.50 per cent. in the finished product. Chlorinated lime, sodium carbonate and sodium bicarbonate are required for making the solution. Since the chlorinated lime varies so greatly in its chlorine content, which is the active ingredient, it is necessary to determine the amount in each case. This is done by thoroughly mixing 20 gms. of the chlorinated lime to be used with one liter of ordinary water, allow to stand for a few hours, with occasional agitation, then filter. Then take 10 mils of the filtered solution, 20 mils of a 1—10 solution of potassium iodide and 2 mils of acetic or hydrochloric acid and titrate dropwise with a deci-normal sodium thiosulphate solution until decoloration is complete. The amount of sodium thiosulphate solution used, in mils multiplied by 1.775 gives the weight of the active chlorine in 100 grams of the chlorinated lime. Then by referring to the accompanying table the amounts of the various agents required to make 10 liters of solution may be obtained.

For instance, if the volume of the thiosulphate solution required is 16.6 mils — 16.6 multiplied by 1.775 equals 29.7 grams (29.7 per cent.) chlorine in 100 grams of the chlorinated lime. This corresponds very closely in the table to

Chlorinated lime	154 gms.
Dry Sodium Carbonate	77 gms.
Sodium Bicarbonate	64 gms.

QUANTITIES OF INGREDIENTS FOR TEN LITERS OF DAKIN'S SOLUTION.

Liter of Chlorinated Lime	*Chlorinated Lime. Gm.*	*Anhydrous Sodium Carbonate, Gm.*	*Sodium Bicarbonate Gm.*
20	230	115	96
21	220	110	92
22	210	105	88
23	200	100	84
24	192	96	80
25	184	92	76
26	177	89	72
27	170	85	70
28	164	82	68
29	159	80	66
30	154	77	64
31	148	74	62
32	144	72	60
33	140	70	59
34	135	68	57
35	132	66	55
36	128	64	53
37	124	62	52

To prepare 10 liters of solution, weigh the agents carefully, place the chlorinated lime and 5 liters of ordinary water in a jar of about 12 liters capacity, agitate well for a few minutes and allow

to stand for 6 to 12 hours. At the same time, dissolve the sodium carbonate and bicarbonate in 5 more liters of water. Pour the solution of the sodium salts in the mixture of chlorinated lime, agitate thoroughly, then allow to remain undisturbed so that the calcium carbonate will settle. At the end of one-half hour, siphon off the liquid and filter through double paper. The filtrate is the Carrel-Dakin solution. Protect from the light.

Since the solution does not keep well, it is wise to verify the strength from time to time as follows: To 10 mils of the solution add 20 mils of a 1—10 solution of potassium iodide and 2 mils of acetic or hydrochloric acid. Titrate this mixture dropwise with a deci-normal solution of sodium thiosulphate until decoloration is complete. The amount of thiosulphate solution in mils multiplied by 0.03725 will give the weight of sodium hypochlorite in 100 mils of the solution, 12 to 13 mils should be required for the reaction. Thus 13 multiplied by 0.03725 equals 0.485 gms. (0.48 per cent.).

The alkalinity may be tested from time to time by dropping a few centigrams of phenolphthalein in powder form upon 20 mils of the solution. There should be no change in tint.

IODUM — IODINE

Iodine is a nonmetallic element obtained from the ashes of sea weed and is found in the mother liquor obtained in the purification of Chile saltpeter. It occurs as bluish-black friable crystals, having a metallic lustre, peculiar odor and sharp acrid taste. Upon heating it gives off a violet colored vapor. One gram is soluble in 2950 mils of water, 12.5 mils of alcohol, 80 mils of glycerin, and very soluble in ether, chloroform and solutions of potassium iodide.

Preparations and Doses.

Iodum. H. and C. 3 ss—j; 2.—4. Dog. Not often used.

Tinctura Iodi. Iodine 7 grams, potassium iodide 5 grams, water 5 mils, and alcohol enough to make 100 mils.

Liquor Iodi Compositus (Lugol's Solution). 5 per cent. of iodine in 10 per cent. aqueous solution of Potassium Iodide.

H. and C. 3 ij—iv; 8.—15. Dog, ♏ ij—x; 0.12—0.6.

* *Tinctura Iodi Decolorata* N. F. This is really a solution of iodides and does not contain free iodine.

Unguentum Iodi. Iodine 4 gms., Potassium Iodide 4 gms., glycerin 12 gms., and benzoinated lard 80 gms.

Incompatibles. Iodine is incompatible with alkaloids, mineral salts, ammonia, carbonates, starch and mucilage of acacia. It acts strongly upon turpentine and some other volatile oils. The tincture

* Unofficial.

is incompatible with water, so should be used only upon dry or dehydrated surfaces (operating areas) as water precipitates the iodine.

External and Local Actions. The action of iodine is quite different from that of the previously discussed halogens. Free iodine is one of the most useful counterirritants. Iodine produces its action in a manner similar to the other halogens; it precipitates proteids and forms easily decomposed compounds with them. For this reason it remains for some time at the point of application, and, since it is volatile, it also penetrates very deeply so that we have an agent of lasting and penetrating properties. Its irritant action, however, is mild, seldom producing more than redness and desquamation together with some smarting at the point of application. Since its action is so mild, and can be graduated by successive coatings, it is valuable to obtain long sensory irritation without deeply injuring the tissues.

Applied directly to the skin, iodine causes some burning and leaves a yellow stain. This discoloration may be removed by a solution of ammonia or hyposulphite of soda. It is very painful to raw surfaces or when injected into serous sacs and causes some inflammation in the latter case.

Taken internally, iodine is absorbed quite rapidly, as the iodides, and some is found in practically all the secretions; it is largely eliminated by the urine, as the iodide. In small doses it exerts the same symptoms as the iodides (see page 379) and may produce iodism under the same conditions. Toxic doses internally are discussed under general discussion of the halogens.

Uses. 1. *Counterirritant.* Iodine is very useful when a mild, persistent action is desired, as in the removal of inflammatory products, edema, rheumatism, arthritis, synovitis, bony growths, etc. The tincture or stronger solutions may be used for this purpose.

2. *Cysts, Enlarged Bursæ, etc.* The tincture or Lugol's solution is used as an injection into cysts, enlarged bursæ, etc. to destroy the cyst wall and produce an adhesive inflammation. This is a very painful procedure and may result in local gangrene. Occasionally, also, sufficient is absorbed to produce general symptoms of poisoning.

3. *Goiter.* In simple goiter iodine in the form of Lugol's solution or the tincture has been used as an injection directly into the gland. There is some difference of opinion regarding its action but it is most generally believed to produce its action as an irritant and not as iodine or the iodides internally.

4. *To reduce enlarged glands.* The tincture or ointment is applied locally.

5. *Parasiticide.* Tincture or ointment, particularly for ringworm.

6. *Absorbent.* For bony growths, etc., generally discussed under counterirritants. (See page 342.)

7. *Antiseptic and stimulant for wounds.* The tincture is a good antiseptic for operating areas. The area should be thoroughly dried with alcohol or other means before applying because water precipitates the iodine and prevents its penetration. The tincture may also be used as an antiseptic for fresh wounds or may be applied to chronic wounds where it is both antiseptic and stimulant. In the form of Lugol's solution 0.25 per cent. in water it is valuable as a uterine and vaginal douche in metritis of cattle. It may be used much stronger if not allowed to come into contact with the vagina, as the uterus will stand much stronger solutions than the vagina.

8. *In periodic ophthalmia of horses* the injection of 2 mils of Lugol's solution into the fatty pad over the eye at 10 day intervals has been found useful.

9. *Internally iodine* is used chiefly in colloid goiter and other glandular enlargements. Thyroid extract is probably of more service in the first condition and the iodides in the second.

℞ Absorbent.
Hydrargyri Chloridi Corrosivi ..... ʒ j
Potassii Iodidi ..... ʒ j
Iodi ..... ʒ jss
Aquæ q. s. .....ad. O. ij
M. Ft. Sol.
Sig. Apply daily with a brush.

℞ Tincturæ Iodi ..... ʒ iij
Olei Terebinthinæ ..... ʒ j
Alcoholis ..... ʒ iv
M. Ft. Sol.
Sig. Apply daily.

℞ Blister.
Iodi ..... ʒ j
Hydrargyri Iodidi Rubri ..... ʒ ij
Adipis q. s. .....ad. ʒ j

℞ Liquoris Iodi Compositi.
Glycerini .....āā ♏ xv
M. Ft. Sol.
Sig. Inject in fatty pad over eye for periodic ophthalmia of horses.

IODOFORMUM — IODOFORM

Iodoform, or triiodomethane, is methyl with three atoms of hydrogen replaced with three of iodine. It is obtained by the action of iodine upon alcohol, or acetone in the presence of an alkali or alkaline carbonate. It occurs as a lemon colored powder or hexagonal crystals, having a peculiar penetrating odor, and sweetish iodine-like taste. It is freely soluble in ether, chloroform and oils, in about 60

parts of alcohol, 80 of glycerin, and feebly soluble in water. It contains 97 per cent. of iodine.

Doses. H. ℥ ss—j; 2.—4. D. gr. ij—viij; 0.13—0.5.

Preparation. *Unguentum Iodoformi* 10 per cent. in benzoinated lard.

Action. Iodoform is a mild anesthetic to raw surfaces and mucous membranes. Iodoform itself is insoluble and probably inactive. It is also stable outside the body but in the presence of tissues or their extracts, especially diseased tissues and their accompanying bacteria, it is slowly decomposed, freeing the iodine. This freeing is brought about slowly but is sufficient to be antiseptic and stimulant to the cells; it is therefore very valuable in treating open sores since it promotes healing by stimulating the cells and also by exerting an antiseptic action. It is quite easily absorbed from raw surfaces, appearing in the urine in a short time as the iodide, although it is also eliminated to some extent by all other secretions. If absorbed too freely it produces serious symptoms which may become fatal. These symptoms consist of depression, contraction of the pupils, nausea and vomiting, very rapid pulse, delirium, stupor and coma. Since the iodides or iodine do not produce cerebral symptoms, it is thought that this action is due to the iodoform itself.

The treatment of poisoning consists in maintaining the strength of the animal and favoring the elimination of the iodoform by injections of salt solutions and alkaline diuretics. Sodium bicarbonate is said to be antidotal to poisoning by iodoform. Vinegar will remove the odor from the hands.

Uses. *Internally.* The only place where iodoform has been recommended internally is in pulmonary tuberculosis, and this has practically been abandoned.

Externally. It is used as a local application to infected wounds. In various ulcers it is very valuable as a dusting powder. In the form of iodoform gauze it is a valuable packing for fistulous tracts, deep wounds, rectal, vaginal and nasal cavities. It may also be injected into these cavities in solution in olive oil or glycerin.

Williams recommends an ounce capsule of iodoform, placed directly into the uterus, for retained afterbirth and metritis of cows.

Iodoform suppositories may be very serviceable in painful hemorrhoids or fissure of the anus, serving a twofold purpose, anesthetic and antiseptic. Iodoform collodion makes a very good protectant dressing for aseptic wounds.

It may be used as a dusting powder, applied as the ointment, in solution in oil, collodion, or glycerin, or in combination with boric acid or tannin.

IODOFORM SUBSTITUTES

On account of the strong, disagreeable, persistent odor which cannot be overcome by the strongest perfumes, many investigations have been made to obtain iodoform substitutes. These have led to several products which have a less disagreeable odor than iodoform. The following are the most important:

* *Iodoformin* is a combination of iodoform with hexamethylenamine. * *Iodoformal* is a combination of iodoformin with ethyl iodide, while * *Iodoformogen* is a combination of iodoform with a coagulated proteid.

These three preparations have a faint iodoform-like odor. Iodoformin is whitish in color, the others, yellow. The first two liberate iodoform in the presence of water. Iodoformin contains 75 per cent. of iodoform and iodoformogen, 10 per cent. The high price and uncertainty of action have limited the use of these preparations.

* IODOLUM — IODOL

TETRA-IODO-PYRRHOL

This is prepared by the action of iodine upon pyrrhol, a principle obtained from bone oil. It contains a little less than 90 per cent. of iodine, occurs as a grayish brown crystalline powder, devoid of odor and taste. It is almost insoluble in water but is soluble in alcohol, ether and oils. It has the advantage over iodoform of being odorless.

THYMOLIS IODIDUM — THYMOL IODIDE

Synonym. Aristol

Aristol is a proprietary drug introduced to take the place of iodoform. It was and still is very expensive but nevertheless gained so much favor among surgeons that, in the 8th revision of the U. S. P., it was introduced as thymol iodide, which it is chemically. It contains about 45 per cent. of iodine, is a light brown or brownish red bulky powder, with a very slight aromatic odor, insoluble in water, slightly soluble in alcohol, but soluble in ether, chloroform, collodion and oils. It is decomposed by light, heat, acids, alkalies, alcohol and mercuric chloride.

Uses. Entirely external as a substitute for iodoform, over which it has the advantage of being odorless, but on the other hand it is unstable, and more costly.

* **Europhen. (Di-Isobutyl-Cresol-Iodide).** This is a cresol iodide made by precipitating an alkaline solution of isobutyl-orthocresol with a solution of iodine in potassium iodide. It contains 25

* Unofficial.

per cent. of iodine, occurs as a light yellow, amorphous powder, of an aromatic odor, soluble in alcohol, ether and oils, insoluble in glycerin and water.

Uses. Substitute for iodoform.

* **Eigon and Diodoform.** Eigon, an iodine proteid and diodoform (iodoethylene), C_2I_4 are yellow odorless powders. They are used as iodoform substitutes but have also been used internally for their iodine effect but have no advantages over the other iodides.

The antiseptic effect of iodoform has also been sought by introducing iodine into the nucleus of the benzol derivatives but the iodine is held so firmly that they do not possess the iodoform action, but are nevertheless antiseptics due to the benzol constituents. Among these preparations are losophan, nosophen, antinosin, eudoxin, sozoidol and picrol.

* **Losophan** (tri-iodo-meta-cresol), occurs as white, odorless needles, almost insoluble in water. This is very irritant and is chiefly used against parasitic skin affections in from 1 to 3 per cent. ointments. It contains 80 per cent. of iodine but does not free it in the tissues.

* **Nosophen** (Tetra-iodo-phenolphthalein), and its bismuth salt, *Eudoxin,* are brown powders, practically insoluble in water. They are used externally, as iodoform.

* **Antinosin,** the sodium salt of *nosophen,* occurs as blue crystals, soluble in water. It is used in solution of 0.1 to 2 per cent. as an antiseptic.

* **Sozoidol** and **Picrol** are oxidized aromatic sulpho acids. Sozoidol is chemically Di-iodo-phenol-sulphoacid. It is used in the form of its salts of mercury, sodium, potassium and zinc as an antiseptic.

IODIDES

The iodides of potassium, ammonium, sodium, strontium, and lead are official. Besides these we have diluted hydriodic acid which is used for the iodide action. Potassium iodide is the preparation most used, so will be discussed in detail, and the differences in the actions of the others pointed out.

POTASSII IODIDUM — POTASSIUM IODIDE

Potassium iodide occurs as colorless, transparent or translucent crystals, or as a white granular powder, having a pungent saline taste, soluble in 0.7 part of water, 2.5 parts of glycerin and 12 of alcohol.

Doses. H. ℥ j—ijss; 5—10. D. gr. iij—xv; 0.2—1.

* Unofficial.

Preparations.

* *Unguentum Potassii Iodidi.* 10 per cent. KI and 0.6 per cent. of Potassium Carbonate.

Incompatibles. Almost everything: mineral acids, mineral salts, alkaloids, spirits of nitrous ether.

Action. Potassium iodide is classed as an alterative because no effects will be noticed if a single moderate dose is administered to a healthy animal, except some increase in secretions and possibly some upsetting of the stomach. It is rapidly absorbed from all parts of the digestive tract and reappears in the secretions in a few minutes after its administration to a man. It is chiefly eliminated by the kidneys but small amounts are also eliminated by the saliva, tears, milk and sweat. There is some belief that small amounts are retained in the body which may account for its accumulation or iodism. Large doses cause burning in the stomach, and gastroenteritis with its attendant phenomena, while the continuous use leads to a toxic group of symptoms, or *iodism.* This action has not been satisfactorily explained but by some is believed to be due to the free iodine into which a small amount of the iodide may be changed. The symptoms of iodism are especially pronounced in the mucous membranes of the respiratory tract and other mucous membranes involved in its elimination. There is pain in the frontal region, sneezing, running at the nose, soreness of the throat, lachrymation, increased secretion of saliva, loss of appetite and sometimes a scaly skin eruption. Some cases may show symptoms of Grave's disease, such as palpitation of the heart, tremors, sweating and loss of weight, probably due to some influence upon iodine in the thyroid gland. In still other cases the prolonged administration of iodine may cause atrophy of the testicles, mammæ, paralysis and blindness. Iodism is important to remember because there is a considerable difference in susceptibility of animals to the drug and also for the reason that the drug is frequently pushed to full effect or until iodism occurs and is them immediately stopped.

Action on Thyroids. Marine and Lenhart found that the thyroids take up iodine, no matter in what form administered and whether the glands were normal, colloid or hyperplastic. They also found that those with hyperplastic glands lost weight for a week or two after the administration of the iodine but then rapidly gained, and that iodine hastened the tendency of all hyperplasias to become colloid.

Uses. 1. *As a specific in actinomycosis.* Administer medium or large doses internally, and apply iodine to the lesion, for several days, then omit for a few days and begin over again. Or administer the iodide until iodism occurs and then stop it for a time.

* Unofficial.

It is reported to be also efficacious in botryomycosis, in which condition it is administered the same as in actinomycosis.

2. *In acute and chronic rheumatism.* Iodide of potash is often very serviceable in either of these forms of rheumatism. Its action cannot be explained and it seems to be more effective in the chronic variety.

3. *As an expectorant in chronic bronchitis and laryngitis,* when the secretions are viscid. This action is believed to be due to reflex effect. It is very useful in bronchial asthma, probably due to its expectorant action.

4. *Absorbent for hyperplàstic fibrous tissues,* as glandular swellings, and chronic inflammatory swellings. It may cure fibrous goiter by causing a disappearance of the fibrous tissue and may be of service in removing colloid goiters.

5. *To remove serous effusions.* It is generally held that potassium iodide will aid in the absorption of effusion into the pericardium and pleura, but this is of doubtful value.

6. *Antidote to chronic metallic poisoning.* The iodides are particularly serviceable in chronic lead and mercury poisoning, by hastening their excretion. There is some doubt of their efficacy in these conditions.

7. *In arteriosclerosis and aneurism* or any condition of high blood pressure, due probably to a decrease in the viscosity of the blood, and an increase in the activity of the thyroid.

8. *Alterative.* The drug has been recommended as an alterative in various conditions in which its true value is unknown.

Administration. Since there is a wide variation in susceptibility to the drug and idiosyncrasies are common, the initial dose should be small and the doses gradually increased as the tolerance permits.

SODII IODIDUM — SODIUM IODIDE

This occurs as colorless, cubical crystals, or white crystalline powder, of a bitter, saline taste. It is unstable in the air as it decomposes into sodium carbonate and free iodine. It is soluble in 0.5 part of water and 3 of alcohol.

Doses. Same as for the potassium salt.

It has the same range of therapeutic uses as the previous salt, but may be less irritating to the stomach.

AMMONII IODIDUM — AMMONIUM IODIDE

Ammonium iodide occurs as small, colorless, cubical crystals, or white powder, of strong saline taste; it attracts water upon exposure to the air, and becomes a yellowish brown color on account of the free iodine. It is soluble in 0.6 part of water and 9 of alcohol.

The *doses* are the same as for potassium iodide.

Uses. This salt is more irritant to the stomach than potassium iodide, otherwise its actions and uses are identical.

STRONTII IODIDUM — STRONTIUM IODIDE

Occurs as colorless or faintly yellow hexagonal plates, deliquescent, bitter taste, and soluble in 0.5 part of water.

Uses. This drug is less active than the potassium salt and also less liable to produce iodism.

PLUMBI IODIDUM — LEAD IODIDE

This iodide really belongs with the lead salts since it is never used internally for the iodide effect. It occurs as a heavy, bright yellow powder, odorless, tasteless, permanent in the air and almost insoluble in water.

Preparation.

Unguentum Plumbi Iodidi.

Action and Uses. This drug is rarely used internally. Externally applied as an ointment, it is very serviceable as a resolvent application for nonsuppurative adenitis. It should be applied thoroughly and rubbed in well with gentle friction.

SULPHURIS IODIDUM — SULPHUR IODIDE

This is made by fusing sulphur and iodine. It is used externally in ointment or liniment in parasitic skin diseases.

ACIDUM HYDRIODICUM — HYDRIODIC ACID

This acid is official as acidum hydriodicum dilutum, which contains 10 per cent. by weight of the absolute acid, also as Syrupus Acidi Hydriodici, which contains 1 per cent. of the acid. These agents are both feeble in action but resemble those of the iodides.

* IODIPIN (IODIZED SESAME OIL)

This is an iodine addition product of sesame oil. It occurs as a thick, yellow to brownish black oil. It is proprietary and is marketed in two strengths, iodopin, 10 per cent. and iodipin 25 per cent. Iodipin, veterinary, is a similar but cheaper preparation.

Action and Uses. It acts in the system similarly to the iodides. It is not decomposed in the stomach but is broken up slowly in the intestines. Its action is claimed to be more lasting than the iodides

* Unofficial.

and iodism is less likely to be caused. The ten per cent. solution is for medication per os and the twenty-five per cent. solution is for hypodermic use.

THYROIDEUM SICCUM — DRIED THYROID GLANDS

Synonym. Desiccated Thyroid Glands

This is the dried thyroid glands of animals which are used for food by man, freed from connective tissue and fat and containing not less than 0.17 nor more than 0.23 per cent. of iodine. By special treatment, thyroiodin and thyroglobulin may be obtained from them.

Doses. Dog gr. ij—v; 0.12—0.3.

The thyroids of most animals contain iodine, those of man and dogs, more than those of the horse, ox, sheep and pig. Yet these animals are as healthy as others and react as strongly after the removal of the glands.

Effects of Removal of the Thyroids (Thyroidectomy). If the thyroids are removed from dogs they soon show reflex excitability and occasionally convulsions, and die within a few days. Thyroid, injected intravenously, a few hours before death will stimulate all the vital functions. In man and monkey, the symptoms develop much more slowly and are characterized by a condition very similar to that of myxedema.

Action. Thyroids have their principal action upon metabolism, increasing both proteid and fat destruction. The action depends upon the iodine content because the ratio of loss is in proportion to the amount of iodine in the glands. Thyroids which do not contain iodine, do not have this action. There is some controversy as to its action on fat metabolism although thyroid has been in use for a long time in the treatment of obesity. Yet thyroid is not an ideal anti-fat because an ideal treatment for obesity should increase the reduction of fat without affecting protein waste. The administration of thyroid at any rate causes tissue waste which cannot be stopped by feeding carbohydrates or fat. The augmented protein elimination accounts for about one sixth of the loss of weight according to Dixon, and the rest must be due to destruction of fat and removal of fluid. There is some clinical evidence that thyroid will promote the union of fractured bones or the growth of bone in normal animals.

Some investigators have considered that thyroid is but an organic form of iodine because in many cases the reaction depends upon the amount of iodine in the preparation, and may be borne out by the similarity of its effects to those of iodine in some conditions, but thyroids produce results in myxedema, cretinism or after thyroidectomy, which no other iodine preparation is capable of producing.

Toxicology. Intravenous doses slow the heart and lower blood pressure by stimulating the vagus center. Continuous full doses produce a group of symptoms (thyroidism): These are anemia, emaciation, loss of appetite, muscular weakness, tremors, nervousness, acceleration of the pulse associated frequently with palpitation, increase in temperature believed to be due to increase in metabolism and, somtimes, bulging of the eyes. The effects are similar to those of exophthalmic goiter.

Uses.

1. In colloid goiter.
2. Rachitis and osteomalacia, and delayed union of fracture.
3. After complete thyroidectomy.
4. In conditions in which it is believed there is an insufficient secretion of the thyroids.
5. In myxedema and cretinism of man.

ANTITHYROID PREPARATIONS

These agents are recommended to overcome a hyperactivity of the thyroids. Most common are:.

* **Beebe's Serum.** The serum from animals whose thyroids have been removed.

* **Thyroidectin.** (*Capsulæ Antithyroideæ*).

Gelatin capsules each containing 0.33 (5 grains) of a powder prepared from the dried blood of thyroidectomized animals. *Dose,* human, or dog.— One or two capsules daily according to need. P. D. and Co.

* **Antithyroidin** — *Mœbius.* The serum of sheep from blood drawn at least six weeks after the removal of the thyroids, preserved by the addition of 0.5 per cent. of phenol. Dose for dog, 0.5—1 mil, (8—15 minims) three times daily, increasing gradually if necessary.

These preparations are not often used in veterinary medicine.

* Unofficial.

CHAPTER XXIV

GROUP OF ARSENIC, ANTIMONY AND PHOSPHORUS

ARSENUM — ARSENIC

The metal is not used in medicine.

ARSENI TRIOXIDUM — ARSENIC TRIOXIDE

Synonyms. White Arsenic, Arsenous Acid, Arsenous Oxide

Arsenic trioxide occurs either as an opaque, white powder, or in irregular masses of two varieties: one, amorphous, transparent and colorless like glass (glassy); the other, crystalline, opaque, and white, resembling porcelain (porcelain). Both varieties are odorless, tasteless, soluble in 30 parts of water (glassy) 100 parts (porcelain), in 15 parts of boiling water, slightly soluble in alcohol and ether, and freely soluble in glycerin and in hydrochloric acid and alkaline solutions.

Preparations and Doses.

Arseni Trioxidum. H. and C. Tonic gr. iij—v; 0.2—0.3.
Vermicide. H. gr. vij—xv; 0.5—1. Sh. and Sw. gr. 1/10—j; 0.006—0.06. Dog gr. 1/60—1/10; 0.001—0.006.

Liquor Acidi Arsenosi. Solution of arsenous acid. A 1 per cent. solution in water and hydrochloric acid. It is especially useful in preparations where Fowler's solution would be incompatible.

Doses. H. and C. ʒ ij—viij; 8—30. Sheep and Pig. ♏ xv—xlv; 1.—3. Dog. ♏ j—x; .06—0.6. Three times daily.

Liquor Potassii Arsenitis. Solution of Potassium Arsenite, Fowler's Solution of Arsenic. This is a 1 per cent. solution in water and potassium bicarbonate, flavored and colored with compound tincture of lavender. Doses are the same as for the above.

Liquor Arseni et Hydrargyri Iodidi. Solution of Arsenous and Mercuric iodides. Donovan's Solution. One per cent. solution of each iodide in water. Doses the same as above preparations.

SODII ARSENAS — SODIUM ARSENATE

Sodium Arsenate occurs as colorless, transparent, monoclinic prisms, odorless, and having a mild alkaline taste; efflorescent in dry

and somewhat deliquescent in moist air; soluble in 1.2 parts of water, slightly soluble in alcohol.

Preparations and Doses.

Sodii Arsenas. H. gr. iij—vij; 0.2—0.5. D. gr. $\frac{1}{64}$—$\frac{1}{12}$; 0.001—0.005.

Sodii Arsenas Exsiccatus — Dried Sodium Arsenate. The same as the above salt with the water of crystallization driven off. About twice the strength of the preceding. It occurs as an amorphous white powder, odorless, and having a mild alkaline taste. Permanent in dry air. Soluble in 3 parts of cold water, freely soluble in boiling water, sparingly soluble in alcohol. *Doses,* one-half those of the preceding salt.

Liquor Sodii Arsenatis, Solution of Sodium Arsenate, Pearson's Solution. One per cent. solution of exsiccated sodium arsenate in water. *Doses,* same as for Fowler's solution.

External and Local Action. Arsenic is antiseptic but is too toxic to be used for this purpose, although it is used to retard post-mortem changes and in dilute solution as a parasiticide. (Dip for sheep.) It is not absorbed from the skin when in dilute solution, but there is reason to believe that it may be absorbed when in concentrated solution. Arsenic is irritant to mucous membranes and raw surfaces, causing painful destruction of the tissue and if applied over large surfaces or packed in wounds and cavities it may be absorbed sufficiently to cause poisoning.

Digestive System. It is generally believed that small doses of arsenic stimulate the appetite and digestion. Large doses are irritant, causing nausea, vomiting, abdominal pain, and diarrhea. The irritant effects appear to be produced after absorption, because they occur late and even after the drug has been administered subcutaneously. Large hypodermic doses cause edema of the intestines on account of increased permeability of the capillaries, together with degeneration and exfoliation of the intestinal epithelium.

Circulatory System. Therapeutic doses may slightly increase the pulse rate. Larger therapeutic doses tend, after a few days, to cause edema of the skin and digestive tract, as shown by puffiness around the eyes or other parts of the body, or by general dropsy, nausea, or diarrhea. This is believed to be due to an increased permeability of the capillaries. The blood pressure is little influenced by therapeutic doses but may fall after toxic ones on account of the loss of serum by transudation.

Blood. Arsenic appears to show its most valuable action upon the blood and blood forming organs. When administered for long periods to young growing animals, the bone marrow becomes more vascular, with an increase in the leucocytic elements, decrease in fat, and little if any change in the erythrocytic elements (Charteris).

There is no change in the number of red cells or in the percentage of hemoglobin in the blood. Charteris found, "From repeated doses large enough to produce cachexia and emaciation in rabbits, the bone marrow undergoes hyaline degeneration accompanied by a decrease in the red cells and hemoglobin."

Arsenic, therefore, tends to increase the leucocytic forming elements of the bone marrow and the leucocytes in the blood, but in serious cases of chronic poisoning, it causes degeneration of the marrow cells, wasting and anemia. It often increases the number of red cells in pernicious anemia of man and diminishes the number of leucocytes in leukemia. How this action is accomplished cannot be stated, but some suggest that it may act upon a parasite or toxin.

Nervous System. Clinical experience indicates that arsenic, in therapeutic doses, is a stimulant to the nervous system. Nervous disturbances occur in both acute and chronic poisoning, but more especially in the latter. The paralysis is usually a polyneuritis, similar to that caused by other poisons, although a few cases of spinal paralysis have been observed.

Bone. In young growing animals in poor condition, arsenic tends to increase the density of the bone. There is no reason to believe that it has any such action in adults.

Metabolism. There is a general belief that medicinal doses of arsenic will favorably influence nutrition, but this action cannot be explained except for the fact that the capillaries of the splanchnic area are rendered more permeable. Toxic doses increase proteid disintegration, increase the output of nitrogen, lessen oxidation and cause fatty degeneration of the epithelium of the digestive tract, liver, heart and kidneys.

Absorption and Elimination. Absorption is fairly rapid from the stomach and intestines if the drug is in solution. Elimination is slow. Most of the drug passes out by the kidneys, but small amounts are excreted by most of the other excretions.

Skin. Arsenic has a beneficial action upon the skin. In man this is shown by an increase of subcutaneous fat and improvement of the complexion. It also renders the coat of animals thicker and more glossy. Its action here cannot be explained, although two theories have been advanced. 1. That it has a specific action upon the skin during its excretion, or 2, that it may increase the lymph flow to the part. There is considerable evidence which would support either theory. There is a tendency to pigmentation of the skin from long use of the drug.

Tolerance. The system may be educated to stand large doses of arsenic if the drug is started in small doses, and gradually increased. After being so treated for a number of days, often months, it is found that animals will show no physiological reaction to doses

several times the toxic ones. Sometimes animals become immune from long continued dosing and " arsenic eaters " are very tolerant to it. This acquired immunity from doses by the digestive tract is probably due to an acquired resistance to absorption, because such animals are no more resistant to its administration subcutaneously than others not previously treated.

Toxicology. Arsenic poisoning is one of the most common found in veterinary practice. It may be caused by the injudicious use of the drug by the laity, may be administered with intent to kill, may be due to careless use of arsenical mange dips, where animals are allowed to drain on the forage, to pasturing in orchards in which the trees have been sprayed with arsenical preparations, or to pasturing on land in the region of smelters, in which case the arsenic is deposited on the forage and is taken in by the animals; or it may be due to carelessness with arsenical preparations used as insecticides, or in rat poisons.

According to Law, the toxic dose for the horse is 140 grains in solution or 3½ drams in powder, cattle 3½ drams to 7 drams, sheep, 2 drams, dogs, 2 grains, but they may recover from larger doses because the larger amounts cause emesis. Hogs may die after receiving 15 grains, but, as in case of dogs, may recover from larger ones.

Poisoning from arsenic may be either acute or chronic.

Acute Poisoning. The symptoms of acute arsenic poisoning are violent colic, weak, irregular, rapid respirations, emesis in vomiting animals, great thirst, violent purging, cold extremities, nervous disturbances consisting of stupor, trembling, convulsions or paralysis. Acute poisoning points to a very rapid absorption because it sets in early. The first noticed symptom is violent gastroenteritis which so closely resembles that of corrosive poisoning that it was formerly believed to be due to the corrosive action of arsenic. The action of arsenic, however, is not strictly local because subcutaneous doses or intravenous doses will produce the same lesions in the gastrointestinal tract as when administered by mouth. Furthermore, arsenic preparations do not form compounds with the proteids, analogous to those of the heavy metals and require a certain period before their action is seen, while corrosives produce their effects at once. On account of the above facts, it is generally believed that the action of arsenic is due largely to its effects after absorption.

Blood pressure falls at the beginning of symptoms of poisoning, due probably to a dilatation of the blood vessels. This is shown by the fact that if the aorta is clamped, the heart will keep up a good pressure. The paralysis is believed to be in the capillaries, because the arterioles will still contract if the peripheral stump of the splanch-

nic nerve is stimulated. The heart becomes rapid, weak and irregular and the vasomotor center depressed.

Sollmann says, " These changes in the capillaries explain practically the whole course of the poisoning. Since *increased permeability* of the capillaries is one of the essential features of inflammation, one need not be surprised that the phenomena of arsenic-poisoning are similar to those produced by an irritating inflammation, although the primal cause is different." The paralysis of the capillaries causes an exudation of serum into the connective tissues. The accumulation of serum raises blisters beneath the mucosa which is soon thrown off as shreds or false membranes, together with large amounts of serum into the stomach and intestines, causing the so-called " rice water stools " of people.

The prolonged gastroenteritis is usually the cause of death.

Chronic Poisoning. Chronic poisoning in animals usually results from the continued faulty dosing with arsenic; or in herbivora, by grazing upon pastures upon which arsenic has been deposited by vapors from smelters.

Symptoms. Here we get a chronic gastrointestinal catarrh, emaciation, hidebound, diarrhea, muscular weakness, paralysis, soreness of the gums, swelling of the eyelids, salivation, and eruption on the skin. The milder but persistent action upon the capillaries gives time for more marked degenerative changes in the body, prominent among which are fatty degeneration of the endothelium of the capillaries themselves, followed by the same changes in the liver, heart, kidneys and muscles. In this type of poisoning there is a tendency toward local effusions, particularly swelling of the eyelids, which is quite characteristic.

Lesions. These consist of inflammation of the gastro-intestinal tract, with ropy, bloody mucus. There may be ecchymoses or blood in the stomach. The presence of large amounts of fluid and shreds of mucus or false membranes with the absence of corrosion is characteristic. Ulceration is not commonly found in cases of acute poisoning, but may be found in the chronic. Petechiæ may be seen in the internal organs in acute poisoning and fatty degeneration in the chronic.

Diagnosis. The diagnosis of acute poisoning is based upon the violent gastroenteritis, distinguished from that of acids and alkalies by the history, absence of corrosion of the stomach and less prominent local symptoms. The rapid onset distinguishes it from poisoning by all other metals. The chronic poisoning is difficult to diagnose because it may be confused with chronic lead poisoning; consequently chemical examination of the organs is the only method of making a positive diagnosis.

Treatment of Acute Type. Use emetics or stomach tube and

follow with purgatives. The antidotes are magnesium oxide, dog, gr. vij—xv; horse and cow, 3iv—v, every 10 or 15 minutes. Powdered iron or water in which hot irons have been cooled are also useful. The symptomatic treatment consists of the administration of mucilaginous drinks to retard absorption, and stimulants such as strychnine, camphor, etc., to combat the weakness and paralysis. Ferri Hydroxidum cum Magnesii Oxido (see under iron salts) has long been considered antidotal, by forming insoluble salts. It should be freshly prepared and administered ad libitum. More recently, one investigator at least, DeBuscher, believes that the compound formed by this agent is more soluble than arsenic trioxide and that it is valueless. The treatment for chronic poisoning is the same as for that of lead, which see page 424. It includes the administration of potassium iodide in large doses and symptomatic treatment of the patient.

Therapeutics. Externally. Arsenic trioxide is used externally for the following purposes:

1. *Caustic and escharotic.* For this purpose it is usually made into a paste and used to remove superficial tumors. Its action is slow and extremely painful. Furthermore, there may be some danger from absorption if it is packed into large cavities.

2. *Parasiticide for mange mites of sheep.* It is usually employed in the form of a dip. Law recommends the following: "Arsenic trioxide 20 lbs., soda ash 20 lbs., soft soap 4 lbs.; these are dissolved in four gallons of boiling water, then enough cool water is added to make 50 gallons, which will suffice for 50 sheep." The compound is worked into the wool for 3 minutes. The wool is then wrung out and the sheep made to stand on an incline for further dripping, and are finally turned into a bare lot to dry. The arsenical dips are so extremely dangerous and require such careful attention that they have been largely replaced by others.

Internally. Arsenic has been used internally for a variety of conditions: anemia, chronic dyspepsia, rickets, osteomalacia, chorea, heaves and vermicide for horses.

1. *Diseases of the blood and blood forming organs.* Arsenic is probably the next best drug to iron in anemia and often gives temporary improvement in cases of pernicious anemia of man. It is often serviceable in leukemia and Hodgkin's disease.

2. *Diseases of bones and joints.* It is often useful in rachitis, osteomalacia and chronic rheumatism.

3. *Chorea and nervous disturbances.* The drug is often serviceable in the so-called "chorea" of dogs, but is by no means a specific for this condition. It is generally administered in ascending doses until saturation occurs, it is then omitted for a few days and then repeated.

4. *Vermicide for horses.* When given in about three or four

times the average dose, arsenic is very serviceable as a vermicide for round worms in horses. After daily administration of large doses for 6 to 8 days it should be followed by a purgative dose of linseed oil, to which two ounces of oil of turpentine have been added.

5. *Skin diseases.* Arsenic is useful in chronic non-parasitic skin diseases, but is contraindicated in the acute. Quitman recommended " Fowler's Solution," internally and locally, for warts in the mouth and upon the muzzle of horses and dogs.

6. *Tonic and alterative.* Small doses of arsenic are recommended in any case of debility.

7. *Heaves.* Arsenical preparations are useful in heaves of horses, but animals require rather large doses. It will relieve the symptoms but will not cure the disease.

Administration. The trioxide is usually combined with iron and strychnine or nux vomica, and administered as a pill or in solution to small animals, or as a solution or powder to the large ones.

It is a common practice to use the liquid preparations of arsenic in ascending doses until saturation is shown; that is, to start with small doses and increase each day until saturation occurs, as is shown by swelling and itching of the eyelids. Fowler's Solution (Liquor Potassii Arsenitis) is most useful, but it is incompatible with solutions of strychnine or other alkaloids or acids and consequently the acid preparation of the same strength (Liquor Acidi Arsenosi) should be used in such cases.

The following prescriptions illustrate the uses of arsenic:

Anemia — Horse.

℞ Arseni Trioxidi ..... gr. ij–iij
Ferri Sulphatis Exsiccati.
Potassii Nitratis .....āā. ʒ j
Nucis Vomicæ ..... ʒ ss
M. Ft. Pulver.
Sig. One powder two or three times daily in feed.

Arsenic Paste.

℞ Arseni Trioxidi.
Acaciæ .....āā. ʒ ij
Solutionis Cocainæ 4 per cent. q. s.
M. Ft. Pasta.
Sig. Apply to wart, or small tumor.

Worms — Horse.

℞ Ferri Sulphatis Exsiccati ..... ʒ j–ij
Nucis Vomicæ ..... ʒ ss
Nucis Arecæ ..... ʒ ij
Arseni Trioxidi ..... gr. x
M. Ft. Pulver.
Sig. One in morning, for 8–10 days. Follow with a purge.

Anemia — Horse.

℞ Liquoris Acidi Arsenosi ..... ʒ ij
Strychninæ Sulphatis ..... gr. j
Tincturæ Ferri Chloridi ..... ʒ j
Aquæ q. s. .....ad. ℥ ss
M. Ft. Sol.
Sig. Give at one dose. Repeat three times daily.

Anemia — Dog.

℞ Ferri Reducti ..... gr. j
Zinci Phosphidi ..... gr. 1/16
Strychninæ Sulphatis ..... gr. 1/120
Sodii Arsenatis ..... gr. 1/20
M. Ft. Pilula.
Sig. One three times daily.

OTHER PREPARATIONS OF ARSENIC

Arseni Iodidum. Arsenic Iodide occurs as orange red, glossy crystals, having the odor and taste of iodine. It is soluble in water and alcohol. *Doses.* H. gr. ij—vij; 0.13—0.5. Dog, gr. 1/60—1/10; 0.001—0.0064. This preparation has been used as an alterative but is not often employed in veterinary medicine.

Cupri Arsenis. Copper arsenite is a yellowish green, crystalline powder, slowly soluble in water, known as *Paris Green* or *Scheele's Green.* It is occasionally used as an intestinal antiseptic in diarrhea, but is of more importance on account of its toxic action.

Sodium Arsenilate. This is proprietary under the name of Atoxyol. It occurs as a white, odorless powder, or crystals, soluble in water. It is claimed to be one-fortieth as toxic as arsenic trioxide. Atoxyol has been recommended as a substitute for arsenic in many diseases, anemia, etc., and as a specific for diseases caused by trypanosomes, surra, etc. It is also reported as serviceable in the treatment of sclerestomum tetracanthum in foals.

Doses. Horse, gr. vij—xv; 0.5—1. Dog, gr. 1/3—iij; 0.02—0.2, gradually increased. It should be given subcutaneously.

Arsacetin. Sodium Acetyl Arsenilate. This preparation is claimed to be less toxic than atoxyol, to keep well and to stand boiling without decomposition. Its uses and doses are practically identical with the preceding drug.

Cacodylic Acid. Dimethyl arsenic acid, is official as *Sodium Cacodylas* (Sodium Cacodylate). It is a white powder, soluble in water.

Doses. H. gr. xxx—lx; 2.—4. Average gr. xlv; 3.0. D. gr. j—iij; 0.065—0.2. Average gr. 1½.

The action and uses are very similar to those of the other arsenic preparations. It is claimed to be less toxic than arsenic, as are the preceding drugs, but the diminished toxicity is due to the facts that they contain less arsenic, the arsenic is slowly eliminated, and they are not so easily dissociable. Whatever benefit they possess is believed to be due to the slow liberation of arsenic.

Sodium cacodylate has been recommended for numerous conditions in human practice, such as psoriasis, syphilis, pseudo-leukemia, etc. More recently it has been recommended in veterinary medicine for distemper of dogs, and for influenza, contagious pleuropneumonia and other infectious fevers of horses.

Administration. Sodium cacodylate may be given in solution, though almost any method of administration may be used. It is usually given subcutaneously or intratracheally in horses and hypodermically in dogs. It may be purchased in ampules ready for administration to small animals, or may be made into solution. It is usually given about every other day. The following formula will serve as a working basis for preparing solutions of the drug, suitable for hypodermic or intratracheal medication:

℞ Sodii Cacodylatis ..... gr. xc
Phenolis ..... ♏ j
Aqua Dest. Steril q. s. ..... ad. ℥ ij
M. Ft. Solutio. Boil and filter through a sterile filter.

Each mil (15 minims) contains approximately 1½ grains of the drug.

* **Salvarsan.** Ehrlich's 606 — Arsenphenol-Amine-Hydrochloride. This is a bright yellow powder of strongly acid reaction and soluble slowly in 10 parts of water. It may be used subcutaneously or intramuscularly but is recommended especially for intravenous administration. It must be made into a fresh neutral or slightly alkaline solution before administration. It is very oxidizable so is kept "in vacuo" or in ampules filled with an indifferent gas. To prepare it for intravenous use, dissolve it in the proportion of 10 grains in 300 mils of physiological salt solution, to which 23 drops of a 15 per cent. solution of caustic soda have been added.

* **Neo-Salvarsan.** This is salvarsan so treated that it is soluble in water and neutral in reaction, so that it does not require the addition of an alkali. It, therefore, requires less attention in preparing doses.

Doses. H. and C. 3xlv—lxxv; 3.—5. Dog, gr. v—x; 0.3—0.6.

The two above preparations were brought into prominence for the treatment of syphilis in man, but have been used by a number

* Unofficial.

of veterinarians in Germany. It is claimed that they may be injected in 15 per cent. solution, hypodermically, intramuscularly or intravenously. The last method is preferable because there is considerable pain and swelling with possible abscess formation when used otherwise.

They have been especially recommended in pleuro-pneumonia and petechial fever of horses. In the former, if given on the second or third day before pronounced changes have taken place in the organs, there may be an increase of temperature for a few hours after administration, but within 24 hours the temperature drops and the animal is improved. Stodtler, reporting on the use of the drug, states that the death rate fell from 5—20 per cent. to $\frac{4}{10}$ of one per cent. In petechial fever the results were also good.

ANTIMONIUM — ANTIMONY

Tartar emetic is the only official salt of antimony used in medicine. Besides this there are the chloride, sulphide and oxide. The action of antimony is quite similar to that of arsenic. The most marked differences are that it is less easily absorbed and causes more local irritation. On account of this irritant action, when given by the mouth to animals which vomit, it is an emetic. Vomiting is always a prominent symptom, no matter how the drug may be given.

ANTIMONII ET POTASSII TARTRAS

Synonym. Tartar Emetic

Tartar emetic occurs as colorless crystals or white powder, having a metallic sweetish taste. It is soluble in 15.5 parts of water, but insoluble in alcohol.

Preparations and Doses.

Antimonii et Potassii Tartras. Expectorant. H. and C. 3ss—j; 2—4. Dog, gr. $\frac{1}{30}$—$\frac{1}{20}$; .002—.003. Emetic. D. gr. j—iij; 0.065—0.2. Cat, gr. ss—j; 0.032—0.065. Hog, gr. iv—x; 0.25—0.65. Vermicide. H. 3ij—v; 8.—20. Ruminatorium. C. 3ij—iv; 8.—15.

* *Vinum Antimonii. Doses.* Dog, exp. ♏ x—xx; emetic, 3j—iv. Contains 4 parts of tartar emetic to 1000.

Syrupus Scillæ Compositus (*Hive syrup*)

Contains in 100 mils:

Squills	8.0 Gm.
Senega	8.0 Gm.
Tartar emetic	0.2 Gm.

Action. Besides having an action similar to arsenic there are some facts that should be brought out.

Externally. Applied to the skin as an ointment it produces

* Unofficial.

papules, vesicles, and pustules, and diffuse abscesses if the application is long continued.

Internally. Tartar emetic is an emetic, expectorant and vermicide. If given in fair doses (1—3 grains) to a dog, there is an increase in secretions from the salivary and bronchial glands and emesis in from 5 to 15 minutes. The action is persistent and is accompanied by much nausea and followed by depression. In smaller doses it acts as an expectorant. It is generally believed that there is no direct action upon the glands of the bronchi but that the action is due to a slight nausea caused by a direct irritant action upon the walls of the stomach. The emesis is probably also due entirely to local irritant action upon the walls of the stomach, although some writers believe that there is some action upon the vomiting center, since it will produce emesis if given subcutaneously or intravenously; but Dixon says, "If the drug is introduced subcutaneously vomiting is still induced, in which case not only are larger doses required, but it takes longer to act. This forms a conclusive proof of its peripheral action, and there is no reason to suppose that it has any direct action upon the center."

Horses do not vomit and stand relatively large doses. Cattle may show active movements of the rumen and may vomit after large doses. For this reason it has been used as a stimulant for that organ.

Large doses cause violent abdominal pain, watery discharges from the bowels, collapse and death.

Absorption and Elimination. Absorption is very slow but is sufficient if the drug is long continued to cause effects similar to chronic arsenical poisoning. It is largely eliminated by the stomach and intestines, but small amounts escape by the kidneys, skin and respiratory tract.

Treatment of Poisoning. This consists of administering tannic acid as the antidote. Demulcents are also indicated. Treat the collapse or threatened collapse with stimulants.

Summary of Action. Emetic, expectorant, vermicide, irritant.

Therapeutics. 1. *Expectorant.* It is an efficient expectorant in acute bronchitis with hard cough and scanty secretions. It is very serviceable here since the expectorant dose is much smaller than that required for emesis.

2. *Emetic.* It is a very marked emetic, but is not often used because it produces so much prostration and is comparatively slow in action.

3. *Vermicide.* Especially for round worms of horses. For this purpose 4 or 5 drams are dissolved in a pail of water and administered to the animal upon an empty stomach as follows, ⅓ at 6 A. M., ⅓ at 8 A. M., and the rest at 9 A. M. (Grimme.)

4. *Ruminatorium.* Especially for impactions and paralysis of the rumen of cattle.

5. *Trypanosome diseases.* Dixon states that it possesses a remarkably toxic action upon trypanosomes when administered subcutaneously.

6. *Externally* it is too violent for use.

Expectorant — Horse.

℞ Ammonii Chloridi.
Antimonii et Potassii Tartratis.....āā ʒ xvj
M. Ft. Chartæ No. 16.
Sig. One morning and night on feed or in water.

or

℞ Ammonii Chloridi.
Antimonii et Potassii Tartratis.....āā. ℥ ij
Liquoris Ammonii Acetatis ..... ℥ viij
Syrupi q. s. .....ad. ʒ xvj
M. Ft. Sol.
Sig. One ounce doses two or three times daily for horse or cow.

Acute Bronchitis in Dog.

℞ Ammonii Chloridi ..... ʒ ij
Antimonii et Potassii Tartratis..... gr. ij
Syrupi Tolutani q. s. .....ad. ℥ iv
M. Ft. Syrupus.
Sig. Teaspoonful every two or three hours.

or

℞ Ammonii Chloridi ..... gr. j
Antimonii et Potassii Tartratis..... gr. 1/30
Sanguinariæ Nitratis ..... gr. 1/100
Extracti Glycyrrhizæ ..... gr. jss
M. et. Ft. Pilula.
Sig. One pill every two hours.

PHOSPHORUS

Phosphorus exists in two forms, the red and the yellow. The red is not volatile, is insoluble in water and fats, is not absorbed and consequently is nontoxic. The yellow is the ordinary variety used. It is soluble in oils, very volatile, and easily absorbed if in a fine state of division or in solution in fats.

PHOSPHORUS — U. S. P.

Properties. Translucent, almost colorless solid, of a waxy luster, and at ordinary temperatures is about the consistency of beeswax. It has a disagreeable odor and taste and when exposed to the air gives off white fumes which are luminous in the dark, and of a garlicky odor. One gram dissolves in about 400 mils of dehydrated alcohol, about 17 mils of chloroform, 102 mils of absolute

FIG. 22.

Section of head of the femur in a calf. A, normal: B, after treatment with minute doses of phosphorus; C, cap of dense bone at the growing point. (After Wegner.) Reproduced, by permission, from Cushny, Pharmacology and Therapeutics, published by Lea and Febiger.

ether, 315 mils of benzene, and in 0.9 mil of carbon disulphide, sparingly soluble in fixed oils. It is almost insoluble in water, to which it imparts its disagreeable odor and taste. On long exposure to air it takes fire spontaneously.

Preparations and Doses.

Phosphorus. H. and C. gr. ⅙—j; 0.01—0.06. Dog, gr. $\frac{1}{100}$—$\frac{1}{20}$; 0.006—.003.

Pilulæ Phosphori, $\frac{1}{100}$ grain each.

**Oleum Phosphoratum,* 1 per cent. phosphorated oil. This was formerly official but has been discarded on account of deterioration. It is best to prescribe phosphorus in an extemporaneous solution.

Action. The chief effects from small or therapeutic doses were demonstrated by Wegner, who found that if administered to growing animals it rendered the bones more dense, diminished the cancellous structure and in time tended to diminish or obliterate the marrow cavity. That these changes are due to a stimulation of the bone-forming tissues and not to a deposit of an excess of the calcium salts was shown by the fact that in animals fed phosphorus, but deprived of calcium, there was the same increased activity of bone-forming cells, but no lime was deposited, so that the bone was soft and of a rachitic appearance.

With the exception of the changes produced in the bones and possibly some effect upon the red blood corpuscles, the effect of phosphorus in medicinal doses is not marked. There is some clinical evidence, however, that it stimulates or improves the tone of the nervous system.

Toxicology. The effects from phosphorus do not take place for several hours and are first shown by intense abdominal pain (colic) and profuse vomiting. The vomitus is luminous in the dark and has a garlicy odor. Following these symptoms the patient usually feels much better (after 24 to 36 hours) and will be apparently normal for 3 or 4 days. Then the symptoms recur. The patient is icteric, liver congested and tender, pulse very quick and feeble, urine scanty and contains bile, tube casts and albumen, increased amounts of ammonia and sometimes sarcolactic acid, leucin, tyrosin and sugar. This condition will last for several days or until the patient dies from heart failure, although he may recover from serious attacks.

Autopsy. The changes found upon autopsy are usually considered as due to changes in metabolism instead of to direct action. Fatty degeneration is widespread, especially in the glands of the stomach and intestines, in the liver, muscles and heart. Ecchymoses are often present and necrotic areas are frequently found in the liver and stomach.

* Unofficial.

Chronic poisoning. This was very common to workers in match factories, and was called "Phosphorism." It is characterized by loss of flesh, anemia, garlicky breath, chronic diarrhea, albuminuria, fragility of the bones, and necrosis of the maxillary bones, which, however, probably never occurs unless the teeth are carious.

Treatment. This should be aimed at removing as much as possible of the phosphorus and oxidizing the remainder. If the patient is seen soon after ingestion, empty the stomach with copper sulphate (30 grains to 2 ounces of water) as an emetic, then administer two or three ounces of a weaker solution (30 grains to the pint of water) to coat any remaining phosphorus with metallic copper, which is soon converted into the insoluble phosphide. Follow this with a cathartic to remove any unabsorbed phosphorus which may have reached the intestines. Potassium permanganate may be used in the same manner, washing the stomach with a 0.1—0.2 per cent. solution, followed by about 5 grains of the drug in eight ounces of water. Hydrogen peroxide may be used in an emergency but since it is so easily decomposed on contact with the body fluids and mucous membranes it can only act by coming in direct contact with the phosphorus. French oil of turpentine has been recommended, but this is almost impossible to obtain, and the ordinary commercial variety is valueless. All oils and fats should be avoided, as they increase the solubility of the drug.

Therapeutics. 1. *Diseases of Bones.* The only logical use of phosphorus in medicine is in rickets, and osteomalacia, where it is recommended as a specific by some, but of doubtful value by others. It is best given in cod liver oil, but may be given in olive or cotton-seed oil. There is some evidence that it will hasten the callous formation in delayed union of bones.

2. *Nerve tonic and aphrodisiac.* There are no grounds for its use in these conditions, although there is some clinical evidence that it may be of some value in nervous disorders dependent upon exhaustion and not to organic changes, neurasthenia, impotence from excess, etc.

Administration. Use only freshly prepared solutions in oil or in keratin coated pills, as it undergoes oxidation very promptly upon standing.

* ZINC PHOSPHIDUM — ZINC PHOSPHIDE

Properties: Dark grayish gritty powder or crystalline metallic fragments, having a faint phosphorus-like odor and taste. It is soluble in alcohol and water.

Doses. Dog, gr. $\frac{1}{40}$—$\frac{1}{10}$; .0016—.0065.

Action and Uses. Very similar to those of phosphorus.

* Unofficial.

ACIDUM PHOSPHORICUM

This is a colorless liquid, containing 85 per cent. by weight of absolute orthophosphoric acid and 15 per cent. of water. Its action is like that of the dilute mineral acids and not at all like that of phosphorus. (See mineral acids.)

* CALCIUM PHOSPHAS PRÆCIPITATUS

White, odorless, tasteless, amorphous powder, almost insoluble in water.

Doses. H. ℥j—ij; 30.—60. D. ℥ss—ijss; 2.—10.

Preparation. Syrupus Calcii Lactophosphatis.

Action. Calcium phosphate has very little if any action. It is but sparingly absorbed and is largely eliminated by the bowels. It has been recommended on theoretical grounds for rachitis, etc., but is of doubtful value.

HYPOPHOSPHITES

The hypophosphites of calcium, sodium, potassium, strychnine, quinine, etc., have been used as nerve tonics on the theory that they furnish phosphorus to the nervous tissues. They are of doubtful value and probably of no value at all since they pass through the system unchanged and may be recovered from the urine as the hypophosphites.

They were frequently prescribed and were official as the syrup (Syrupus Hypophosphitum) containing 4.5 per cent. of calcium hypophosphite, 1.5 per cent. each of sodium and potassium hypophosphite, 0.2 per cent. of diluted hypophosphorus acid with glycerin, sugar and water, or as the compound syrup (Syrupus Hypophosphitum Compositus) containing 3.5 per cent. of calcium hypophosphite, 1.7 per cent. each of potassium and sodium hypophosphites, 0.2 per cent. each of iron and manganese hypophosphites, 0.1 per cent. of quinine hypophosphite, 0.01 per cent. of strychnine hypophosphite, 0.37 per cent. of sodium citrate, 1.5 per cent. of hypophosphorus acid, with sugar and water. *Dose.* Dog, ℥j—ij; 4—8.

The syrup is probably an inert preparation, while it is generally believed that any benefit derived from the compound syrup was due to the iron, strychnine and quinine which it contained. The hypophosphites were also frequently prescribed with cod liver oil in the form of an emulsion — Emulsum Olei Morrhuæ cum Hypophosphitibus.

GLYCEROPHOSPHATES

The glycerophosphates are the salts of glycerophosphoric acid. They exist as two classes: the primary or acid glycerophosphates and

* Unofficial.

the secondary or normal glycerophosphates. The second variety is the one most used in medicine. Those of calcium and sodium are generally preferred.

Calcii Glycerophosphas. Calcium Glycerophosphate occurs as a white, odorless and almost tasteless powder, soluble in water, almost insoluble in boiling water, soluble in dilute acids but insoluble in alcohol or ether. *Dose* for the dog is 5 grains in powder, capsule or tablet.

Sodii Glycerophosphas. Sodium Glycerophosphate occurs in white, monoclinic plates or scales, odorless, of a saline taste, soluble in water, insoluble in alcohol. Doses same as for the above.

These salts were introduced in medicine as substitutes for the phosphates and hypophosphites, on the ground that they were more rapidly assimilated, since they more nearly resemble lecithin in composition, than do the others. Their superiority has not been substantiated experimentally or clinically and it is doubtful if they have any advantage over the inorganic phosphates in phosphorus metabolism. They are useful in exhaustion, slow or tardy convalescence, and neurasthenia as "nerve tonics."

LECITHIN

Lecithin consists of glycerophosphoric acid and a fatty acid combined with choline. It contains about 4 per cent. of phosphorus. Lecithin is a constituent of plant and animal tissues, especially of nervous tissue and yolk of eggs. The lecithins vary somewhat in composition according to their source, but this does not appear to effect their action. Animals take in fairly large amounts of lecithin with their food and there is no evidence to show that small daily doses are necessary when a good diet is available.

NUCLEIN

Nucleins are combinations of proteids with nucleic acid and are derived from the nucleoproteids of cells. The term "nuclein" is often carelessly employed, being frequently used when nucleic acid is meant. Cells in general are rich in nucleoproteids. The best-known varieties are those obtained from wheat embryo and yeast. The composition of the nucleins of commerce varies greatly, according to their method of preparation, but the nucleic acids are definite complex chemical compounds. Nucleic acid from yeast, the usual commercial variety, contains about 10 per cent. of phosphorus.

The nucleins and nucleic acids were introduced as remedies for tuberculosis in man. They have been claimed to increase the number of white corpuscles and consequently were recommended in the treatment of infectious diseases, but their usefulness in these conditions is, at the most, questionable. They break down in the organism into purine bases and phosphoric acid.

CHAPTER XXV

SALTS OF THE HEAVY METALS

In general the action of the salts of the heavy metals may be described as local and systemic or general.

Local Action. With the exception of the salts of Arsenic and Antimony, the local action of the heavy metals is due to the fact that they form chemical compounds with the proteids of the tissues with which they come into contact.

When solutions of dissociable salts of heavy metals are added to proteid solutions, a precipitate of the albuminate of the metal is formed. This precipitate may be a dense, tough, insoluble mass in some cases, or in others it may be less dense, and soluble in an excess of the proteid. (Salts of mercury.) Those which form insoluble precipitates only destroy tissues when in strong concentration and consequently serve as superficial caustics, while in dilute solutions they are astringents. On the other hand, those which penetrate deeply are powerful caustics but not astringents.

The salts of the heavy metals produce their astringent action in one of three ways, according to Dixon —"The soluble salts of the metals may form albuminates and liberate free acid; the metal may be locally absorbed, so constricting the part, and reducing the secretions; and lastly, insoluble salts like those of Bismuth may cover and mechanically protect the surface."

The local action is largely due to the dissociated metal or metallic oxide ion, although the salts of the stronger acids owe part of their action to the acid set free when the salt combines with the proteid, because in this combination an albuminate is formed and the acid freed. This action is more noticeable when strong solutions are used and may be so pronounced as to make the action more irritant than astringent.

A certain tolerance to the corrosive action may be acquired if small doses or weak solutions are used at first. This cannot be satisfactorily explained but may be well illustrated by the tolerance to arsenic of the arsenic eaters of Tyrol.

All metallic salts are antiseptic, due to their power of coagulating the proteids of the bacterial cells.

Systemic Action. This action depends upon the absorption of the metals into the body and the fact that they must be absorbed as the ion. Sollmann says, "All metals are practically equal in

toxic action provided they are introduced into the body. (The alimentary tract in this case is not within the body.) For instance the main difference in the toxicity of arsenic and iron is due to the fact that arsenic is easily absorbed and iron is not. With few exceptions (arsenic, mercury, and uranium), there are no metals absorbed sufficiently rapid to cause acute poisoning, unless a corrosive dose has been given. Other metals, lead, silver, iron, are absorbed more slowly. As discussed under the local action, all metallic salts in strong solution produce corrosion of the digestive tract. They would therefore be absorbed and produce the general action, if the animal survived the local action."

As in case of other substances, metals must be in a soluble form to be absorbed. This solubility does not mean that they must be given in soluble form, as it makes but very little if any difference in what form they are administered, because they will be converted into the insoluble chlorides in the stomach, the insoluble carbonates in the duodenum or into double salts with the proteids (albuminates) which are soluble in an excess of the proteids, in which condition they may be absorbed. They may also pass into the large intestine as the sulphide, escape absorption and render the feces black.

The excretion of metallic salts is even slower than the absorption, so that they frequently accumulate in the body and cause chronic poisoning (cumulative action) when they have been taken for a sufficient time in too small amounts to cause immediate results. A single large dose may also cause chronic poisoning. The principal channel of elimination is by the digestive tract, no matter in what way they have been administered, although a small amount is excreted by the kidneys. The intestines may be irritated at the points of elimination, as is shown by diarrhea and enteritis.

Sufficient amounts are eliminated by the kidneys to cause a marked nephritis, characterized by the ordinary phenomena of that condition. If the poisoning is of the chronic variety, there may be interstitial nephritis or cirrhosis of the kidneys.

The systemic effect is very similar with all metals and consists of a fall in blood pressure due to paralysis of the blood vessels and to direct action upon the heart. This is followed by or attended with disturbances of the central nervous system.

The local (astringent and irritant) effects of the salts of the heavy metals are used therapeutically, but the systemic action is of more importance from a toxicological standpoint.

IRON

Iron is an important constituent of the body and is essential for life of the higher plants and animals. It is found in animals particularly in the hemoglobin of the blood and has a close relationship to the oxygen-carrying powers of the red blood cells. Since hemo-

globin is being constantly destroyed and eliminated as the coloring matter of the urine and feces, more iron must be absorbed to replace that which is cast off. Under normal conditions animals take a sufficient amount with the food to satisfy this want.

Local Action. The local action of iron is similar to that of the other metals. The insoluble preparations have no effect upon the unbroken skin or upon the digestive tract, unless they are converted into soluble form by the secretions. *Ferrous* salts form soluble compounds with the proteids which are neither irritating nor corrosive, while the *ferric* salts precipitate the proteids in an insoluble form and are therefore irritant and astringent. The soluble salts are antiseptic and disinfectant on account of their action upon proteids.

Internally. Iron is an astringent and may cause constipation. It forms loose compounds with the proteids of the digestive tract. It may be absorbed from different parts of the digestive tract, but chiefly from the duodenum. According to some authors, a portion of the iron is converted into the chloride by the hydrochloric acid of the gastric juice, in which form it combines with the proteids. Upon reaching the duodenum it is decomposed by the alkali into the carbonate.

Absorption. Dixon says, "Whether the iron is present in a soluble or insoluble form, absorption of iron granules takes place through the epithelial cells. These granules are taken up by the leucocytes of the mucosa, and ultimately are carried into the portal vein, although some find their way into the mesenteric lymph glands." As in case of most other metals, iron is more rapidly absorbed than eliminated. The excess is deposited in the liver, spleen and bone marrow until used or excreted. In the liver, iron exists as easily decomposed granules (ferratin).

Excretion. Iron is mainly excreted by the bowels, but a small amount escapes in the urine. An excess of iron in the feces stains them black on account of the formation of sulphides or tannates due to the presence of hydrogen sulphide and ingesta with which it comes in contact.

Hemoglobin. Under normal conditions enough iron is taken in the body with the food to supply what is needed and in such cases its administration will have no effect upon the hemoglobin or number of red cells. But, in anemias, iron will increase both the per cent. of hemoglobin and the number of red cells. There is no direct evidence to show whether iron supplies the necessary material for these processes, promotes absorption of iron or simply stimulates the blood-forming organs.

Summary of Action.

1. Locally iron is astringent, styptic and caustic.
2. Internally. a. Iron stimulates hemoglobin formation and

improvement of nutrition in certain anemic conditions, but not in health.

b. It increases the reserve stock of hemoglobin.

c. Iron has an arsenic-like action when injected intravenously, but this is unimportant from a therapeutic standpoint.

Therapeutics.

1. *Locally.* Tincture of the chloride of iron is used as an astringent and hemostatic; the subsulphate, as a styptic and the sulphate (copperas), as an antiseptic and disinfectant for cesspools, etc.

2. *Internally.* The most important use of iron is in the treatmen of anemic conditions. It is especially useful in those cases in which the per cent. of hemoglobin is diminished. After severe hemorrhage the blood will return to normal much more rapidly under the influence of iron. It is of less value in secondary anemias than in primary and of doubtful value in pernicious anemia. Iron is contraindicated in conditions of gastric irritation.

3. *Antidote* to arsenic poisoning.

Administration. Preparations of iron are usually given per os and in order to prevent undue irritation of the stomach should be administered during or after feeding. Some of the organic preparations have been recommended because they are less irritant, but they are expensive and little better than the inorganic preparations. Reduced iron, the carbonate and sulphate are the least irritant of the inorganic preparations. They are usually administered to large animals in the form of powders and to the smaller ones, in pills. Tincture of the chloride of iron is used when a liquid preparation is desired. The sulphate or dried sulphate are the most popular iron preparations for large animals, but the carbonate and reduced iron are sometimes used. The carbonate or reduced iron is most often used for the small animals and is given in pills after meals. If it is necessary to administer iron hypodermically, one of the soluble forms, such as ammonioferric citrate, may be used in freshly prepared, well diluted solution.

Incompatibles. Iron salts are incompatible with all preparations containing tannic or gallic acids, ammonia, alkaline carbonates and mucilage of acacia.

FERRUM — IRON

Ferrum is metallic iron in the form of fine, bright wire. It is only used in the production of preparations of iron.

FERRUM REDUCTUM — REDUCED IRON

Synonyms. Iron by Hydrogen, Quevenne's Iron

Reduced iron is iron reduced to the metallic state by the action of hydrogen upon ferric oxide. It should contain not less than 90 per cent. of metallic iron. It occurs as a very fine grayish-black lustreless powder, without odor or taste. It is insoluble in water or alcohol.

Doses. H. 3j—ij; 4.—8. D. grs. j—v; 0.06—0.3.

Reduced iron is used as a hematinic. When pure it is not irritating and but slightly astringent.

FERROUS SALTS

* FERRI CARBONAS — FERROUS CARBONATE

Synonym. Green Ferrous Carbonate

This is an unstable preparation. It is used in the preparation of saccharated ferrous carbonate.

Preparation.

Ferri Carbonas Saccharatus — Saccharated Ferrous Carbonate.

This is ferrous carbonate protected from oxidation by sugar. It should contain not less than 15 per cent. of ferrous carbonate. It occurs as a greenish-brown powder, gradually becoming oxidized by contact with air, odorless, and having at first a sweetish, afterward a ferruginous taste. It is but slightly soluble in water.

Preparations and Doses.

Ferri Carbonas Saccharatus. H. not used. D. gr. v—xv; 0.3—1.

Massa Ferri Carbonatis (Vallet's Mass). Contains about 42 per cent. of ferrous carbonate with sugar and honey. *Dose.* D. gr. iij—vij; 0.2—0.5.

Mistura Ferri Composita (Griffith's Mixture). Compound iron mixture contains carbonate of iron in suspension with potassium sulphate, myrrh and sugar. *Dose.* D. 3j—iv; 4.—16.

Pilulæ Ferri Carbonatis (Blaud's Pills). Each pill contains about 1 grain of ferrous carbonate made with crystallized ferrous sulphate and potassium carbonate. *Dose.* D. 1—2 pills.

* Unofficial.

Therapeutics. The above preparations are used only as hematinics. Since they are comparatively free from astringent action they are convenient ways of administering iron. The saccharated carbonate or Blaud's pills are usually preferred.

FERRI IODIDUM — FERROUS IODIDE

Synonym. Protiodide of Iron

Iodide of iron occurs as white crystalline masses, soluble in water with partial decomposition. It is used in the following preparations:

Syrupus Ferri Iodidi (5 per cent. by weight of the salt). *Dose.* D. ♏v—xx; 0.3—1.3.

Pilulæ Ferri Iodidi (each one grain of the salt). *Dose.* D. 1—2 pills.

These preparations may be used when it is desired to combine the action of iron and iodine. They are of some value in adenitis and rachitis.

FERRI SULPHAS — FERROUS SULPHATE

Synonyms. Green Vitriol, Copperas, Iron Protosulphate

Iron sulphate occurs as pale bluish-green monoclinic prisms, without odor, and having a saline styptic taste: efflorescent in dry air. On exposure to moist air the crystals oxidize and become coated with brownish yellow, basic ferric sulphate, in which condition it should not be used. It is very soluble in water, insoluble in alcohol.

Doses. H. ʒ ij—iij; 8—12. Sh. and Sw. gr. xv—xxx; 1.—2. D. grs. ij—v; 0.13—0.3.

Preparations.

Ferri Sulphas Exsiccatus — Dried ferrous sulphate.
Doses. H. ʒ j—ij; 4.—8. Sh. and Sw. gr. viij—xv; 0.5—1. D. gr. j—v; 0.06—0.3.

Ferri Sulphas Granulatus — Granulated ferrous sulphate.
Doses. Same as for iron sulphate.

Therapeutics. Ferrous sulphate is an astringent externally. Internally it is astringent and hematinic and consequently is very serviceable in forms of anemia with looseness of the bowels. The dried sulphate is often prescribed for the large animals.

Copperas is quite extensively used as a disinfectant and deodorant for cesspools, etc.

FERRIC SALTS

FERRI CHLORIDI — IRON CHLORIDE

Chloride of iron occurs as orange-yellow, crystalline pieces, odorless or faint odor of hydrochloric acid, and having a strongly styptic taste. It is freely soluble in water, alcohol, glycerin or ether.

Preparations.

Liquor Ferri Chloridi. Solution of ferric chloride contains about 29 per cent. of anhydrous ferric chloride and an excess of hydrochloric acid.

Dose. H. ʒ ij—iv; 8—16. Sh. and Sw. ♏ x—xx; 0.6—1.5. D. ♏ ij—x; 0.13—0.6.

Tinctura Ferri Chloridi.

This is a hydroalcoholic solution of ferric chloride containing 13.28 per cent. of the metallic salt, corresponding to about 4.6 per cent. of metallic iron.

Doses. H. ʒij—℥ij; 8.—60. S. and Sw. ♏ xv—xxx; 1.—2. D. ♏ v—lxv; 0.3—3.

Liquor Ferri et Ammonii Acetatis (Basham's Mixture). Solution of iron and ammonium chloride contains 4 parts of tincture of iron, 6 parts of diluted acetic acid, 50 parts of solution of ammonium acetate, 12 parts of aromatic elixir, 12 parts of glycerin and water to make 100.

Dose. D. ʒ j—iv; 4—16.

Therapeutics. Chloride of iron and the solution are rarely used internally. Externally they are styptics and may be used to stop minor hemorrhages. The solution well diluted may be found useful in hemorrhages from the stomach and intestines but is worthless in other forms of internal hemorrhages.

Tincture of chloride of iron is also an astringent and hematinic. It may be useful for its astringent action as a wash for stomatitis and pharyngitis in the proportion of half a dram to the ounce of water, or as in the following prescription:

Pharyngitis.

℞ Tincturæ Ferri Chloridi ..... ℥ ss
Potassii Chloratis ..... ʒ j
Glycerini ..... ʒ ij
Aquæ q. s. .....ad. O. j
M. Ft. Solutio.
Sig. Use as a wash for pharyngitis; one ounce every 2–3 hours.

The tincture is frequently used as a hematinic but is more liable to disturb digestion than other iron preparations. It is also liable to injure the teeth. It is frequently prescribed as follows:

Tonic for horse or cow.

℞ Tincturæ Ferri Chloridi ..... ℥ ij
Strychninæ Sulphatis ..... gr. xv
Liquoris Acidi Arsenosi ..... ℥ viij
Aquæ q. s. .....ad. ℥ xvj
M. Ft. Solutio.
Sig. One ounce three times daily.

Basham's mixture may be used as a hematinic for small animals.

FERRI PHOSPHAS — FERRIC PHOSPHATE

Synonyms. Ferri Phosphas Solubilis U. S. P. VIII, Soluble Ferric Phosphate

Ferric phosphate, U. S. P. is ferric phosphate rendered soluble by the presence of sodium citrate. It belongs to the scale preparations of iron, see p. 410.

LIQUOR FERRI SUBSULPHATIS — SOLUTION OF FERRIC SUBSULPHATE

Synonym. Monsel's Solution

This is an aqueous solution of variable composition containing an amount of basic ferric sulphate corresponding to not less than 13.57 per cent. of metallic iron. The residue left upon evaporation of this solution to dryness is called *"Monsel's Powder."*

Therapeutics. Monsel's solution and powder are strong styptics. They are less irritant than the solution of the chloride but form a hard black scab which is objectionable. The scab may cover deeper hemorrhages if the solution is poured into a wound and for this reason it is better to apply the solution or powder upon cotton or gauze. With the better methods of controlling hemorrhage at hand, these preparations are rarely used. Solution of the subsulphate diluted with a little water may be of service to check bleeding from the stomach or intestines but, like other local hemostatics, is worthless for other forms of internal hemorrhage.

LIQUOR FERRI TERSULPHATIS — SOLUTION OF FERRIC SULPHATE

This is an aqueous solution which should contain about 36 per cent. of normal ferric sulphate, corresponding to not less than 10 per cent. of metallic iron. It occurs as a reddish brown liquid, almost odorless, having an acid, strongly styptic taste, and an acid reaction. It is used in the preparation of the antidote for arsenic.

FERRI HYDROXIDUM — IRON HYDROXIDE

Iron hydroxide is only used in the preparation of the antidote for arsenic.

Preparation.

Ferri Hydroxidum cum Magnesii Oxido — Ferric Hydroxide with Magnesium Oxide.

Ferric hydrate is made by precipitating any liquid preparation of iron with an alkali. Ferric hydrate with magnesium oxide is made by adding magnesia in excess. This is prepared as follows:

Solution of Ferric Sulphate, 40 mils
Magnesium Oxide, 10 grams
Water, a sufficient quantity.

Since great haste is essential in the preparation of this mixture it should be kept on hand in separate bottles as:

1. Mix the solution of ferric sulphate with 125 mils (4 ounces) of water and keep in a large well stoppered bottle (1000 mils 1 quart).

2. Magnesium carbonate 10 grams, rubbed to a smooth mass with water, transfer this to a bottle holding 1000 mils (1 quart) and fill about three fourths full with water.

For use shake #2 thoroughly, add it to #1 and shake until smooth. Given in large doses, dogs one half to 4 ounces, horses and cattle 8—16 ounces.

FERRI ET AMMONII SULPHAS — FERRIC AMMONIUM SULPHATE

Ferric ammonium sulphate, ferric alum occurs as pale, violet octohedral crystals, without odor and having an acrid, styptic taste. It is soluble in 2.7 parts of water, insoluble in alcohol, efflorescent in air. Ferric alum is a stronger astringent than alum. It has no other use.

* FERRI HYPOPHOSPHITUM — FERRIC HYPOPHOSPHITE

Iron hypophosphite occurs as a white or grayish white powder, odorless and nearly tasteless; permanent in air.

Dose. H. not used. D. gr. j—v; 0.6—0.3.

This has the same action as the other hypophosphites but in addition has some value as a hematinic. It is rarely used in veterinary medicine. See Hypophosphites.

* Unofficial.

FERRI VALERAS — FERRIC VALERIANATE

This is the ferric salt of valerianic acid. It may be employed along with the other valerianates when a hematinic action is desired. The valerianates are not active drugs. See page 158.

SCALE PREPARATIONS OF IRON

These preparations are so named because concentrated solutions of them are spread upon glass and allowed to evaporate so that the salts may be procured in the form of scales. The following are the most important:

Ferri Citras.
Ferri et Ammonii Citras.
* Ferri et Ammonii Tartras, U. S. P., VIII.
* Ferri et Potassii Tartras, U. S. P., VIII.
* Ferri et Quininæ Citras, U. S. P., VIII.
* Ferri et Strychninæ Citras, U. S. P., VIII.
Ferri Phosphas.
* Ferri Pyrophosphas Solubilis, U. S. P., VIII.

These preparations are only used in small animal practice. The average dose of all with the exception of iron and ammonia citrate (grs., viij; 0.5) and Iron and strychnine citrate (grs. ij; 0.12) is grs. iv (0.3). They are used in the preparation of certain syrups, glycerites and elixirs.

FERRUM ALBUMINATUM

There are several albuminates or proteid compounds of iron. Bung, first demonstrated that iron was present in the tissues and food as the nucleo-albuminate and succeeded in isolating such a compound from the yolk of eggs which he called *hematogen*. This differs from the inorganic salts in resisting the action of sulphides. Bung believed that the inorganic iron salts were not absorbed and only benefited anemia by combining with the hydrogen sulphide, which would protect the iron in the food from reduction by the same agent until absorption took place. These theories have been disproved by other investigators and it is generally believed that the inorganic preparations are very capable of absorption. Some of the organic preparations, however, are less disagreeable to the stomach and may be slightly more readily absorbed. Schmiedeberg obtained a preparation similar to hematogen from pig's liver which he named *"ferratin"* (7—8 per cent. of iron). This is now prepared by the action of iron salts on egg albumen. Dose for the dog is grs. iij—x; 0.3—0.6.

* Unofficial.

HEMOLS

Hemols are prepared by the reduction of hemoglobin through zinc dust, and *Hemagallol* by the precipitation of blood with pyrogallol.

COPPER AND ZINC

Copper and zinc have quite similar actions. When administered per os to animals which are able to vomit, they produce a specific irritant action, causing vomition before any corrosion occurs, so that quite large doses are relatively non toxic, unless administered in concentration or to animals which are unable to vomit. Externally they are astringents, mild caustics and antiseptics.

CUPRI SULPHAS — COPPER SULPHATE

Synonyms. Blue Stone, Blue Vitriol, Cupric Sulphate

Copper sulphate occurs as large transparent, deep blue triclinic crystals, or as a blue granular powder, odorless, and of a nauseous metallic taste. It is soluble in 2.5 parts of water and 500 of alcohol. Dose as an astringent or vermicide is:

H. and C. ℥ ss—iij; 0.2—12. Dog gr. ¾—jss; 0.03—0.1. Emetic. Dog. grs. ij—x.

Action. Copper sulphate is astringent in dilute solutions, caustic in concentrated ones. Internally it causes emesis by action upon the nerves of the stomach before corrosion takes place, i.e., in vomiting animals. It also has some reputation as a vermicide.

Copper and its salts are specific poisons for the lower forms of plant life. A very small amount in the water, such as is obtained by dragging bags of the sulphate through water, behind a boat, is sufficient to keep down the growth of algæ without affecting the higher plant life or injuring the animal life. It is, also, said that contaminated water left in a copper vessel will become aseptic but it has been found that this takes an unreasonable amount of time, and that there is little if any advantage over vessels made of other metals. Considerable faith has been placed upon weak solutions of copper sulphate as an antiseptic, but it has been found that one cannot rely upon solutions below 1—1000.

Toxicology. Acute poisoning is characterized by severe abdominal pain, violent vomiting and purging. Autopsy shows gastroenteritis with ulcers in some cases.

Treatment. Administer potassium ferrocyanide, magnesia, sodium carbonate and soap. Demulcents and albuminous material should be freely given.

The chronic type of poisoning is of doubtful occurrence.

Therapeutics.

1. *Emetic.* It is a prompt and powerful emetic but should not be repeated if results do not follow the first dose. It is particularly serviceable in phosphorus poisoning as it forms an insoluble coating of copper upon the phosphorus.

2. *Caustic.* Particularly for ulcerative stomatitis, conjunctivitis, etc.; fouls of sheep and cow, or fistulous tracts. It may be employed as the crystals or made up into sticks for this purpose or may be used in fistulous tracts and fouls in strong aqueous solution. Solutions of 5—15 grains to the ounce of water are useful in conjunctivitis, vaginitis, and urethritis.

3. *Vermifuge.* It has been recommended as a vermifuge for sheep and horses. For horses it is usually combined with iron sulphate and for sheep given in solution as follows: One pound (avoir) of copper sulphate is to be dissolved in 9½ gallons of water. Doses, ages 3 months, ¾ oz.; 6 mo. 1½ oz.; 12 mo. 2½ oz.; 18 mo. 3 oz.; 24 mo. 3½ oz.

* **Copper Oleate.** This is made by precipitating a solution of copper sulphate with a solution of castile soap. It occurs as light or dark green, greasy masses. It has been recommended in 20 per cent. ointment for mange of cats and dogs, but the results from its use are not encouraging.

ZINCUM — ZINC

The element is official in the forms of irregular granulated pieces, or thin sheets, or moulded into thin pencils or in fine powder. The metal itself is not used in medicine. The following preparations are official: acetate, precipitated carbonate, chloride, oxide, sulphate; phenosulphonate, stearate, and valerate.

ZINCI SULPHAS — ZINC SULPHATE

Synonym. White Vitriol

Properties. Colorless transparent rhombic crystals, odorless and of an astringent metallic taste. Freely soluble in water and glycerin but insoluble in alcohol.

Doses. Astringent. H. 3 ss—ij; 2.—8. D. gr. ½—3; 0.03—0.2.
Emetic. Dog gr. x—xxx; 0.6—2.
Emetic. Swine gr. iv—xvj; 0.5—1.0.

Action. Zinc sulphate in solution is caustic, irritant or astringent according to concentration. Large doses cause vomiting in a similar manner to the copper salt. Toxic doses produce severe gas-

* Unofficial.

troenteritis. The treatment of poisoning consists of administering alkalies and their carbonates, and albuminous drinks like milk and eggs.

Therapeutics. Externally as astringent in catarrhal and suppurative conjunctivitis, ½ to 2 grains to the ounce of water. In otorrhea and open wounds stronger solutions are employed. Internally it is sometimes used as an emetic, especially in poisoning by narcotics. It is not often used internally as an astringent.

℞ Zinci Sulphatis ..... ℥ vj
Plumbi Acetatis ..... ℥ j
Aquæ, q. s. .....ad. O. j
M. Ft. Lotio. White Lotion.

These two drugs are chemically incompatible; they form zinc acetate which goes into solution and lead sulphate which is insoluble in water. Nevertheless white lotion is very frequently employed in veterinary medicine for bruises, open wounds, scratches, etc. It may be applied upon cotton or gauze under a bandage.

ZINCI ACETAS — ZINC ACETATE

Zinc acetate occurs as soft white, six sided monoclinic plates, of a pearly lustre, acetous odor and astringent metallic taste. One gram is soluble in 2.3 mils of water, and 30, of alcohol. Uses and actions same as the sulphate.

ZINC CARBONAS PRÆCIPITATUS

This is an impalpable white powder of varying composition, corresponding to not less than 68 per cent. of Zinc oxide; odorless, tasteless and insoluble in the ordinary menstrua. An impure form, Calamine, was formerly official.

Action and Uses. Protectant, astringent and antiseptic in acute inflammations of the skin, as eczema, scratches, burns, etc.

℞ Zinci Carbonatis Præcipitatis.
Zinci Oxidi .....āā ℥ ijss
Glycerini ..... ℥ j
Liquor Calcis ..... ℥ ij
Aquæ Rosæ q. s. .....ad. ℥ vj
M. Ft. Lotio.
For Eczema.

ZINCI OXIDUM — ZINC OXIDE

This is a very fine amorphous, white or yellow white powder, free from gritty particles, without odor or taste and insoluble in alcohol and water.

Doses. H. D. gr. j—vj; 0.06—0.3.

Preparation. *Unguentum Zinci Oxidi.* 20 per cent. in benzoinated lard.

This ointment is very useful as a dressing for burns, eczema, scratches, etc. A dusting powder of zinc oxide, talc and starch is very useful in moist eczema.

℞ Zinci Oxidi.
Talci Purificati .....āā. ʒ j
Amyli ..... ʒ ij
M. Ft. Desiccant Powder.

℞ Zinci Oxidi ..... 2.
Adipis Benzoinati ..... 8.
M. Ft. Unguentum Zinci Oxidi.

Lassar's Paste.

℞ Acidi Salicylici ..... 2.
Zinci Oxidi.
Amyli .....āā. 24.
Petrolati ..... 50.
M. Ft. Pasta.

℞ Olei Lini.
Liquoris Calcis.
Zinci Oxidi.
Cretæ .....āā. 100.
M. Ft. Pasta Zinci Oxidi Mollis. (Unna and N. F.)

ZINCI CHLORIDUM — CHLORIDE OF ZINC

This occurs as a white or nearly white granular powder, or in porcelain like masses, or moulded into pencils, very deliquescent, odorless, of a caustic taste. Freely soluble in water and alcohol.

Preparation. *Liquor Zinci Chloridi.*

This is not prepared from the chloride but from metallic zinc. It contains about 50 per cent. of zinc chloride.

Zinc chloride is the most caustic and least astringent of the zinc salts. It is used almost entirely as a caustic or antiseptic and irritant according to the strength of the solution. It is used more particularly as a caustic in fistulæ, fouls in cattle and sheep, shoe boils, canker, etc. It may be used in strong solution for this purpose or as a paste. Some even push the pencils into the sinuses. For strong caustic action a 20 per cent. solution should be used or it may be made into a paste in this proportion with flour and water. Chloride of zinc is the base of most of the drug treatments for cancer. It is usually applied as a paste for this purpose.

℞ Sanguinariæ Radicis.
Zinci Chloridi .....āā ℥ iij
Pulv. Acaciæ.
Aquæ .....āā ℥ j

M. Ft. Pasta. To be applied upon gauze or packed into a fistula and left two or three days. This is the "so called" German caustic. Very similar to a proprietary veterinary remedy called dynamite.

Fouls in Sheep and Cows.

℞ Zinci Chloridi ..... ʒ j
Aquæ ..... ʒ vj
M. Ft. Solutio. Use as an injection once daily for 3 or 4 days, then reduce three times.

ZINCI STEARAS — ZINC STEARATE

This salt occurs as a fine white bulky powder, tasteless and having a faint, characteristic odor. It is insoluble in water, alcohol or ether. Its action and uses are similar to the oxide. It may be used in 50 per cent. ointment or as the powder.

ZINCI VALERAS — ZINC VALERATE

Zinc valerate occurs as white, pearly scales, or as a white powder having the odor of valeric acid, and a sweetish astringent and metallic taste. It has been used as an antihysteric in human medicine and for chorea of dogs but is of questionable, if any, value. Dose for dogs, gr. j—iij; 0.06—0.18.

Zinc Phenolsulphonate is discussed under phenol, p. 452.

ARGENTUM — SILVER

Silver is absorbed *very slowly*. Furthermore it is reduced to the *inactive state* as soon as it enters the body, according to Jacobi, so, that it cannot lead to *general poisoning* and the only evidence of its absorption is a *dark discoloration* of the skin after prolonged administration (Argyrism). This stain is the result of the deposition of *metallic silver* in the connective tissue of the corium, sweat glands, smooth muscle, etc. It is rarely seen in animals.

The effects produced by silver when introduced intravenously differ from those caused by other metals mainly in the prominence of nervous symptoms. These nervous disturbances are *paralytic* and mainly peripheral in origin. The paralysis is *largely motor* beginning with that of the posterior extremities, followed by some depression of the respiratory center, stimulation of the vasomotor center followed by paralysis. There are *no therapeutic* indications except for its *local action*. The cyanide, oxide and nitrate are official but the nitrate is the one most used.

ARGENTI NITRAS

Synonym. Silver Nitrate

Silver nitrate occurs as colorless, transparent, rhombic tabular crystals, becoming gray or grayish-black on exposure to light in the presence of organic matter; odorless, caustic metallic taste and soluble in 0.54 part of water, and 30, of alcohol. It turns dark upon exposure to light so should be protected from it.

Doses. H. gr. v—xv; 0.3—1. Sh. and Sw. gr. ij—iij; 0.13—0.2. D. gr. ⅙—½; (0.01—0.03).

Preparations.

Argenti Nitras Fusus. Silver nitrate toughened with hydrochloric acid and moulded into hard white sticks or pencils (Lunar Caustic).

* *Argenti Nitras Mitigatus* (Mitigated Caustic). This appears as moulded cones or pencils. It is made by fusing 3 parts of silver nitrate, and 6, of potassium nitrate.

Incompatibles. Silver nitrate is incompatible with organic matter, bromides, chlorides, iodides, cyanides, sulphates, carbonates, phosphates, arsenates, and hydrochloric acid. It is explosive with creosote.

Action. Silver is one of the *most toxic of the metals* to *bacteria and protozoa* but *relatively non toxic to* mammals. It possesses a great affinity for proteids and is irritant, caustic or astringent according to concentration. Applied to the skin, the nitrate is a *superficial caustic* or escharotic. Its action is *superficial* because it forms compounds with the tissues which are not soluble in an excess of the proteid. The eschar is at first white but later becomes black by oxidizing in the light. In order to remove the black stain from the hands or skin it is necessary to wash the stain with a solution of potassium cyanide or paint with tincture of iodine, and bleach with a solution of sodium hyposulphite. In dilute solution it is an unirritating astringent and antiseptic to mucous membranes or raw surfaces, precipitating the proteids of the tissues and contracting the bloodvessels. In concentration it is escharotic but always of a superficial action on account of the impermeable membrane formed, which prevents penetration. It is also a very active antiseptic.

Internally in therapeutic doses there is no action besides that of *astringent and antiseptic.* Its action is largely confined to the stomach because it is so easily precipitated by proteids, chlorides and acids. The astringent action is entirely exerted upon the stomach unless it is administered in keratin covered pills.

Absorption and Elimination. Silver nitrate is largely elim-

inated by the bowels without undergoing absorption. The fact that argyrism takes place, shows that it is absorbed to some extent. Its elimination after absorption is not well known but is usually regarded as taking place slowly by the urine. Argyrism of the conjunctiva may result from the use of silver in the eye and it is said to be more common from the organic preparations than from the nitrate.

Toxicology. In large doses silver nitrate is a severe poison, causing *profound gastroenteritis* with abdominal pain, nausea, vomiting and purging. White patches of corrosion may be seen in the mouth soon after administration but these turn black upon oxidizing.

Treatment. Sodium chloride is the best antidote because it forms the insoluble silver chloride. Administer demulcents and follow with symptomatic treatment.

Therapeutics.

1. *Antiseptic.* Silver foil is used as an antiseptic, nonirritant dressing for surgical wounds.

2. *Stimulant to inflamed mucous membranes and ulcers.* 10 to 40 grains to the ounce of water or as the stick. It is very useful in ulcers of the cornea in which condition it may be applied as the stick or in strong solution for thorough disinfection, then follow with daily installation of a 1 per cent. solution.

3. *Remove Excessive Granulations.* Silver nitrate in form of the stick is probably the best agent we have for this purpose, but is not a good caustic for snake or dog bites because of its superficial action.

4. *Internally.* It is chiefly used for its local action upon the gastro-intestinal canal. It is the next best drug to Bismuth for chronic gastric catarrh and gastric ulcer. It is also used in acute and chronic inflammations of the intestines but is not generally so useful as in gastric troubles.

Administration. For action upon the stomach the drug should be administered in pill form upon an empty stomach, 20 to 30 minutes before meals. It is often combined with powdered opium or the extract of hyoscyamus for this purpose. If desired to act upon the intestine, it must be administered in keratin coated pills. Aqueous solutions should always be prepared with distilled water as there are enough chlorides in ordinary water to precipitate the salt. Since the nitrate oxidizes in the light, solutions must be kept and dispensed in amber or blue bottles.

ORGANIC SILVER COMPOUNDS

Since silver is such an active germicide and the nitrate has the undesirable properties of precipitating proteids and chlorides, many

attempts have been made to produce a compound that would retain the desired qualities of the nitrate but not possess the undesired ones. The most important of these preparations are:—Argyrol, Protargol, Argentamin, Actol (Silver Lactate), Itrol (Silver Citrate), and Largin. Besides these, there is the soluble allotropic form of silver suggested by Crede (Argentum Solubile).

* **Argyrol** (Silver Vitellin). This is a compound of silver and a vegetable proteid containing about 30 per cent. of metallic silver. It is one of the best organic preparations on account of its high percentage of silver, extreme solubility and nonirritant action. It is used in 5 to 25 per cent. solutions. Argyrol is particularly useful as an astringent and antiseptic for mucous membranes, especially those of the eye, nose, vagina and urethra.

* **Protargol.** This is also a proteid salt of silver containing about 8 per cent. of the metal. It occurs as a fawn-colored powder, freely, but slowly soluble in water. Protargol is an active nonirritating germicide useful in the same class of conditions as mentioned under argyrol. In purulent conjunctivitis it is used in from 1 to 10 per cent. solution in water.

* **Argentamin.** This is a 10 per cent. solution of silver nitrate in a 10 per cent. solution of Ethyl-enediamin. The object of the last preparation is to prevent the precipitation of proteids and chorides. It is decomposed by light. It is said to be useful in from 3 to 5 per cent. solution for conjunctivitis and keratitis.

* **Actol.** Silver Lactate. White, odorless and tasteless powder, soluble in about 20 parts of water. It is a powerful germicide. Solutions of 1—1000 will kill most organisms in 5 minutes.

* **Itrol.** Silver Citrate. This resembles the lactate in appearance but is less irritating and quite insoluble in water. It has been recommended as a dusting powder and as a 1—1000 solution for sterilizing instruments.

* **Largin** is a proteid compound of silver containing about 11 per cent. of silver. Used in 0.5 to 1.5 per cent. solution.

* ARGENTUM SOLUBILE

Synonyms. Soluble Silver, Crede's Salt, Collargol, Colloidal Silver

This is an allotropic form of metallic silver containing about 87 per cent. of that metal. It is easily soluble in water. It may be used intravenously, subcutaneously, by inunction, per rectum or by the mouth. At one time Crede's salt was strongly recommended as a treatment for septicemia, mastitis, bronchitis, pneumonia and other bacterial diseases. Its intravenous administration is not dangerous if carefully made, but may be followed in a few hours by rigor, which is not very serious. A 1—3000 solution

* Unofficial.

has been recommended as a wash for mucous membranes or body cavities. Solutions decompose when exposed to light but may be kept for a long time if protected from it. It is used in from 2 to 5 per cent. solution in distilled boiled water intravenously, the dose being for the horse 3 ss—j; for the dog, gr. j—ij. For inunction *Crede's Ointment* offers the best method of administration. This is a 15 per cent. preparation of the drug with lard and wax. The inunction is useful in local infections, and should be applied after the skin has been scrubbed with soap and water and dried with alcohol.

Dieckerhoff has recommended collargol in the treatment of purpura of the horse in daily intravenous doses of 25 mils of a 2 per cent. solution. More recent results have not been so satisfactory and at the present time the drug is rarely employed.

BISMUTH

Bismuth is official in the following forms:

Bismuthi Subcarbonas. Bismuth subcarbonate, a white, insoluble powder, odorless and tasteless.

Dose. H. and C. 3 j—iv; 4.—15. Dog. gr. v—lx; 0.3—4.

Bismuthi Subnitras. Bismuth Subnitrate. Character and doses similar to the preceding drug.

Preparation. *Magma Bismuthi.* Milk of bismuth.

Dose. D. 3 ss—ij; 2.—8.

Bismuthi Subsalicylas. Bismuth Subsalicylate. Characters similar to the preceding salts. Dose one half that of the carbonate.

Bismuthi Subgallas. Bismuth Subgallate, Dermatol. Yellow, insoluble powder, dose same as the preceding.

Bismuthi Citras. Bismuth citrate. Insoluble, white powder, rarely used in medicine but is used in the manufacture of bismuth and ammonium citrate. *Dose* same as for the subcarbonate.

Bismuthi et Ammonii Citras. Bismuth and ammonium citrate. White, soluble powder. *Dose,* same as for the carbonate.

Action. Bismuth is used entirely for its local action.

Externally and Locally. The various insoluble preparations have a marked healing action when applied to mucous membranes and raw surfaces. They dry the secretions and form a protective covering to the wound. With the exception of the subnitrate their action is purely mechanical and is due to fine particles of the powder plugging the lymph and blood capillaries. The subnitrate is believed to be more astringent and antiseptic than the others due to the liberation of nitric acid in the presence of water and the secretions of the tissues.

The salts of bismuth act physically when given by mouth. They adhere to the mucous membrane of the stomach and protect it from

irritation. Upon reaching the intestines they act in the same way and protect the mucous membrane from stimulation by the food and secretions. Consequently, peristalsis is diminished and there is a tendency to check diarrhea. Most of the bismuth is eliminated from the bowels unchanged. Some is changed into the sulphide in the large intestines. This gives the feces the characteristic black color. Animals taking large quantities sometimes have a garlicky breath but this is due to impurities (Tellurium) and not to the bismuth.

There is no reason to believe that there is any marked differences in the action of the various salts. The soluble salt is decomposed in the stomach to the insoluble oxychloride, so that it has no advantage over the insoluble ones.

Therapeutics. *Externally.*

1. As dusting powders for burns, wounds, and skin diseases. They may be used alone or mixed with starch in various proportions. When mixed into a paste with glycerin and water they are serviceable as dressings for burns but may be too toxic for wide applications. The subgallate (Dermatol) has been especially recommended as less toxic but appears to be about as toxic as the other preparations.

2. For fistulæ and chronic sinuses. Some practitioners have good results by injecting a bismuth paste in these conditions. Injections are not usually recommended more frequently than once a week.

Internally.

1. To check nausea, vomiting and gastric irritation in gastritis, and other conditions. It is one of the most popular drugs for these conditions in small animal practice.

2. To check intestinal irritation either in simple fermentative diarrhea or in a true inflammation of the intestines. The subnitrate, subgallate and subsalicylate are often preferred and may be combined with some intestinal antiseptic.

The following prescriptions are representative:

For Gastric Irritation.

℞ Bismuthi Subnitratis ..... grs. x
Cerii Oxalatis ..... grs. x
M. Ft. Pulver.
Sig. Give at one dose. Repeat in half hour intervals if necessary.

or

℞ Bismuthi Subnitratis.
Cerii Oxalatis .....āā. gr. ij
Stovainæ or Cocainæ Hydrochloridi..... gr. 1/12
M. Ft. Capsula.
Sig. One every hour.

Diarrhea, Dog.

℞ Bismuthi Subnitratis ..... ℥ j
Phenolis Salicylatis ..... ℥ ss
M. Ft. Chartæ No. VI.
Sig. One every six hours.

Bismuth Paste.

℞ Bismuthi Subnitratis ..... ℥ j
Petrolati ..... ℥ ij
M. Ft. Pasta.

CERIUM

The only salt of cerium used in medicine is the insoluble oxalate.

CERII OXALAS — CERIUM OXALATE

Properties. Cerium oxalate occurs as a white or slightly pinkish, odorless powder, insoluble in water and alcohol.

Doses. Dog gr. x—xxx; 0.6—2. Cat gr. v—xv; .33—1.

Action and Uses. Cerium oxalate resembles the insoluble bismuth salts in action and uses. Like the bismuth salts it is protectant and may be of considerable service to check vomiting due to irritation of the stomach, but does not check vomiting of central origin. Baehr and Wessler found it non toxic in 50 gram doses in dogs and believed the ordinary doses of a few grains to be too small. They recommend 30 to 60 grains as the human dose.

It is used to check nausea and vomiting due to irritation of the stomach and is frequently combined with bismuth for this purpose.

℞ Cerii Oxalatis.
Bismuthi Subnitratis .....aa. ℥ ij
Ipecacuanhæ ..... gr. iij
M. Ft. Chartæ No. xii.
Sig. One every hour for a dog with gastritis.

PLUMBUM — LEAD

Lead salts differ from the other heavy metals in being astringent instead of corrosive. They may produce sufficient corrosion to be absorbed but not sufficient for acute poisoning from systemic effects, no matter how administered or in what amounts. The small amounts absorbed are not sufficient for acute poisoning but since lead is excreted slowly, it fulfills the conditions necessary for cumulative action if the dosing or exposure is prolonged.

Single moderate doses of the acetate or other salts do not exert any effect beyond the digestive tract where they are astringent. Large doses of lead salts act as irritant poisons and produce violent

gastroenteritis, shown by nausea, vomiting, thirst and usually diarrhea, although constipation may be seen. Death is usually preceded by coma, convulsions and collapse.

Absorption. Lead salts are absorbed from all surfaces of the body, the skin as well as the digestive tract. There is no absolute proof as to the form in which lead is absorbed but it is generally believed to be absorbed as a soluble lead albuminate.

Elimination. The salts of lead are largely eliminated as the sulphide without undergoing absorption. The part which is absorbed is excreted by most channels of elimination, with the possible exception of the sweat, although many believe it is excreted to some extent in this secretion. The greater part is cast off by the epithelium of the skin and digestive tract, although a considerable amount is excreted in the urine. Potassium iodide will hasten its elimination for a time but soon ceases to influence the process. Lead is often deposited as the sulphide on the edge of the gums, giving the characteristic "lead line." The part retained in the body soon disappears from the blood and is largely stored in the liver and other organs.

The following table from Heubel was obtained by examination of a dog killed with lead and gives some idea of the distribution of lead in the body:

Liver	0.03 —10 per cent
Kidney	0.03 —0.07
Brain	0.02 —0.05
Bones	0.01 —0.04
Muscles	0.004—0.008
Blood	Traces.

Toxicology. Lead poisoning may be conveniently divided into the acute and chronic types. The acute is due to its corrosive action before absorption, and the chronic, to its effects after absorption.

There are numerous sources from which sufficient amounts of lead may be obtained to cause poisoning. One of the most common is from lead pipes used for carrying drinking water. These pipes are quite safe for hard water as they soon become crusted over with insoluble lead sulphate. On the other hand, soft water, especially, if it contains quantities of CO_2, easily dissolves enough lead to produce chronic poisoning. A fairly safe method of determining the danger from this source is the examination of the inside of the pipe. If the interior is found to be corroded and dull in appearance there is little danger, while if it is bright, it indicates that the lead is being dissolved. Other sources of lead are, the vegetation in the vicinity of lead smelters, lead paints, scrapings

from paint buckets thrown upon the ground, paint buckets or recently painted troughs, and buildings. Men frequently become poisoned by handling the lead salts, or by using them in the arts (painters). Lead salts are present in some wall papers and tinned goods are sometimes dangerous if there is too large a percentage of lead in the solder or upon the tins.

Toxic Doses. This has not been well established, and varies greatly with the species of animal, idiosyncrasy, general condition and preparation of lead given. Lander gives the following provisional figures for minimum fatal doses of lead acetate:

Horse	7500 grains
Cow	720 grains
Sheep	450 grains

Some of the lead used in paint (carbonate) must be much more toxic because there are records of fairly small amounts causing death in cattle.

Horses are relatively resistant to lead and very few cases of lead poisoning have been noticed among them. Cattle, on the other hand, are quite susceptible. The different species are most susceptible in the following order: cattle, pigs, sheep, dogs, horses.

Symptoms of Poisoning. Acute. This results from a single large dose and the symptoms are those of gastroenteritis as mentioned above, and are entirely due to local corrosive action. There may be some nervous disturbances as stupor, coma, delirium, or muscular tremors.

Chronic Lead Poisoning or Plumbism. This is remarkable from the standpoint of length of time which the sickness may last. Cases are on record where animals survived for 58 weeks. It usually extends over several weeks or months. The usual symptoms are those of gastrointestinal disorder, with lead line on the gums, constipation or diarrhea, loss of appetite, thirst and tucked up abdomen. The nervous system is also extensively involved. This is shown by paralysis of the extensors of the extremities so that the animals stand upon the knees in front and toes behind. Besides this there may be general paralysis, convulsions, anesthesia, dizziness, tremors, delirium, coma and blindness. The general symptoms are anemia, short breathing, emaciation, acceleration of the pulse, edema and interstitial nephritis. The paralysis is usually considered as due to peripheral neuritis and the delirium, convulsions, etc., to some action upon the brain or cord. Colic and constipation which are common symptoms in man, are rarely observed in animals.

Lesions. In acute poisoning there is usually evidence of corrosion. Particles of lead may also be found in the stomach or intestines of the animals. Frequently pieces of lead paint will be

found. The lesions found in chronic poisoning vary so that little diagnostic importance can be placed upon them.

Treatment. Acute. First remove the cause as soon as possible. In acute poisoning administer a sulphate, preferably epsom or Glauber's salts, so as to convert the drug into as insoluble a form as possible. Then remove the contents from the stomach with an emetic or stomach tube if this can be done. If not, administer an excess of one of the above mentioned salts to produce purgation and carry off the insoluble compound. Treat the resultant gastro-enteritis with anodynes and demulcents.

Chronic Poisoning. The removal of the lead is also the chief indication in chronic poisoning. This should be accomplished as mentioned under acute poisoning. Then administer large doses of potassium iodide to hasten the elimination of the poison.

General Uses of Lead. The uses of lead depend entirely upon its local astringent action. It is recommended by some for internal administration, but others consider it too dangerous to be ever used in this manner.

PLUMBI ACETAS

Synonyms. Lead Acetate, Sugar of Lead

Lead acetate occurs as colorless, shining, transparent, monoclinic prisms or plates, or heavy white, crystalline masses or granular crystals, having a faintly acetous odor and sweetish, astringent and finally metallic taste, efflorescent. Soluble in 1.4 parts of water and 38 of alcohol.

Doses. H. 3 j—ijss; 4.—10. Cow gr. xv—xlv; 1.—4. D. gr. ¾—iv; 0.05—0.26 once or twice daily.

Its action has been previously discussed.

Therapeutics. *Internally,* for its astringent action. It has been used in obstinate diarrheas and hemorrhages from the stomach and bowels, usually combined with opium.

Externally it is used entirely for its astringent and sedative action. It is sedative and astringent to wounds, sprains, bruises, etc. Lead acetate is an ingredient of White Lotion (see under Zinc salts). The old lead and opium wash is usually made of the subacetate of lead but the acetate may be substituted. (See ℞ 1.) This is very useful as a sedative and astringent for bruises, sprains, inflammations, etc. Lead acetate should not be used as an eye wash if there is any abrasion of the cornea as it may form a permanent deposit of lead and obscure the sight.

PLUMBI SUBACETAS — SUBACETATE OF LEAD

This preparation of lead is so unstable that it is only used in solutions.

Liquor Plumbi Subacetatis contains lead acetate 18, lead oxide 11, and water to make 100, or 25 per cent. of subacetate of lead. The *dilute* solution — *Liquor Plumbi Subacetatis Dilutus* — contains 1 per cent. of subacetate of lead or 4 per cent. of the stronger solution.

Liquor Plumbi et Opii. N. F. Lead and Opium Wash.

Therapeutics. The stronger solution diluted with 3 or 4 parts of water is useful as an application in acute eczema, contusions, etc. Diluted 1 to 4—8 in ointment it is useful in scratches, and acute skin diseases.

The weaker solution is not strong enough for much benefit but is frequently used as lead and opium wash (2 parts of lead water to 1 of laudanum).

℞ Plumbi Acetatis ..... ʒ j
Tincturæ Opii ..... ʒ j
Aquæ q. s. .....ad. ʒ viij
M. Ft. Lotio.

This solution is chemically incompatible, but nevertheless has been quite widely used as an application to bruises, etc.

* PLUMBI IODIDUM — LEAD IODIDE

Lead iodide is a heavy bright yellow powder, without odor and sparingly soluble in water and alcohol.

Preparation. *Unguentum Plumbi Iodidi* — 10 per cent.

Lead iodide is used for its iodine action. It has been recommended as a desiccant powder in thrush of horses, and as an ointment in non suppurative adenitis.

℞ Sodii Iodidi ..... ʒ j
Plumbi Iodidi.
Olei Olivæ .....aa. ʒ ijss
M. Ft. Unguentum.
Sig. Apply under bandage for pustular dermatitis of extremities of dog. Said to be specific. (Udall.)

* PLUMBI NITRAS — LEAD NITRATE

Lead nitrate occurs in white translucent octohedral crystals; it is odorless, and has a sweetish astringent, metallic taste. Soluble in 2 parts of water. It is used as a caustic either in pure form or concentrated solution in canker of horses.

PLUMBI OXIDUM

Synonyms. Red Lead, Litharge, Lead Oxide

Lead oxide occurs as a heavy reddish yellow powder or minute scales, odorless, tasteless and insoluble in the ordinary menstrua.

* Unofficial.

Rarely used except in preparation of Goulard's Extract and lead plaster.

Preparation.

Emplastrum Plumbi. Lead Plaster. Diachylon Plaster.

Lead plaster is prepared by adding lead oxide to a hot solution of equal weights of lard and olive oil. It makes a useful protective dressing for superficial ulcers and bed sores. Equal parts of lead plaster and petrolatum make an efficacious application in subacute eczema. Lead Plaster also enters into all the official plasters and Diachylon Ointment.

Unguentum Diachylon.

℞ Lead plaster ..... 50 gm.
Oil of lavender..... 1 gm.
White Petrolatum ..... 49 gm.
Melt the lead plaster and white petrolatum, strain, cool, and add the oil of lavender.

HYDRARGYRUM — MERCURY

Mercury differs from the other metals in having a marked specific toxic action upon protoplasm. It is toxic to both higher and lower forms of life and has very strong antiseptic properties. Its action is due to its affinity for proteid molecules. Mercury forms albuminoids with the proteids of the tissues which are soluble in an excess of the albumen, alkali or sodium chloride solution, so that it is quite readily absorbed. It differs also from the other metals in exerting a definite constitutional action which lasts for some time after its administration, due to the slowness of elimination. Furthermore, while most metals are harmless in their free or metallic state, mercury is very toxic. It is absorbed and distributed throughout the body rapidly on account of its being volatile, liquid and easily oxidized. Mercury compounds are absorbed from all surfaces of the body and consequently may be administered per os, inunction, inhalation and fumigation.

Elimination. Mercury is eliminated slowly, chiefly by the intestinal canal but also to some extent by the urine, saliva, sweat and milk. The elimination by the kidneys starts promptly but is very slow and has been known to persist for 8 days after a single dose. It is largely retained in the body in the internal organs as in the case of lead, and soon disappears from the blood.

If small amounts are administered over a long period of time, the first symptoms will be noticed in the mouth, as shown by salivation, soreness of the gums and teeth, and fetor of the breath. Later, if the administration is kept up, the gums will become swollen, the teeth, loosened and fall out, salivation will be profuse, tongue and glands, enlarged and the bones, necrotic. These symptoms con-

stitute what is known as mercurial ptyalism. The general health also suffers as is shown by anemia, loss of flesh, fever, chills, thirst, anorexia, vomiting and purging.

The mercuric salts are more toxic and irritant than the mercurous. The administration of a single large dose of one of them (the sublimate) is soon followed by burning in the throat, esophagus, stomach and intestines. Nausea, vomiting and purging of a bloody mucus takes place. There may be dysuria, anuria and collapse if the patient does not die from shock or collapse due to the corrosion. Even a single large dose may lead to chronic poisoning, death being delayed for several days and being finally due to lesions in the gastro-intestinal canal, or nephritis. The animals remain conscious till the last as the nervous system is not affected early. In chronic cases the general symptoms are overshadowed by the local or corrosive action. These are most prominent in the gastro-intestinal tract, no matter in what way or form mercury is given, and consist of gastro-enteritis, which begins in the upper part of the tract as mentioned under ptyalism, and extends to the intestines. It is violent in the lower portion of the bowels, causing severe abdominal pain and bloody discharges from the bowels. Death may be due to gastro-enteritis, uremia on account of the nephritis, or to prostration.

The insoluble preparations (calomel) in medicinal doses are cathartics causing quite copious discharges, attended with but little pain. They also serve as diuretics, probably due to some stimulating action upon the tubules of the kidneys. Mercury preparations are also useful when applied to glandular or other exudations of a serous or fibrinous nature. They are also strong antiseptics.

The toxic doses of mercuric chloride for the different animals are given as:

120	grains	for	the	horse.
120	"	"	"	cow.
60	"	"	"	sheep.
3–5	"	"	"	dog.

Autopsy. The mucosa is always inflamed and often ulcerated. The kidneys show acute parenchymatous nephritis, and in addition to this, frequently contain deposits of lime in the tubules which are fairly suggestive of mercurial poisoning.

Treatment of Poisoning. *Acute poisoning.* Administer milk or egg albumen to form the albuminates, and remove these with a stomach tube or emetic to prevent absorption. Then give demulcents to sooth the irritated membranes. The systemic treatment is purely symptomatic.

Chronic Poisoning. Administer potassium iodide to hasten the elimination and treat the other conditions symptomatically.

For Ptyalism. Stop the drug. Wash the mouth with a strong solution of potassium chlorate. Give atropine to check the saliva, potassium iodide, to hasten the elimination, and tonics and stimulants, to support the animal.

Therapeutics. 1. *Germicide.* The soluble forms have great antiseptic properties but also have some disagreeable features, being very irritant, toxic, corrode instruments and in the presence of albuminous material are converted into inert and insoluble albuminates; nevertheless, they are very popular germicides. The bichloride is usually employed.

2. *Cathartic.* The insoluble preparations, calomel, blue mass, and mercury with chalk, are just sufficiently irritant to stimulate peristalsis. They are not suitable for habitual constipation but to thoroughly unload the bowels, especially in the early stages of infectious fevers. (Distemper of dogs.)

3. *Diuretic.* Calomel and blue mass are very effective in subacute dropsical effusions in cardiac or hepatic disease.

4. *Absorbent.* Ointments of mercury are very useful in subacute and chronic inflammations.

5. *Irritant* and *Counterirritant.* The soluble preparations are very serviceable as irritants and are favorite remedies in veterinary medicine for this purpose in bony enlargements, spavin, etc.

Administration. The salts of mercury are usually given per os in veterinary practice. For external action they are applied either in alcoholic solution or in ointments.

HYDRARGYRUM — MERCURY

Synonym. Quick Silver

Mercury is chiefly derived from the sulphide or cinnabar. It occurs as a heavy, silvery white, mobile, odorless and tasteless liquid, specific gravity of 13.59 and is the heaviest known liquid. It is insoluble in ordinary solvents but is soluble in nitric acid.

Preparations.

Massa Hydrargyri — Mass of Mercury — Blue Mass; mercury 33; oleate of mercury 1; althaea 15; glycerin 9; honey of rose 32. Blue mass is mercury extinguished with oleate of mercury, honey of rose and glycerin, with a hardening excipient added.

Doses. D. gr. ss—xv; 0.03—1.

Uses. Blue mass is used as a laxative and diuretic, particularly in canine practice. It is an excellent cathartic to unload the bowels in the early stages of infectious fevers (distemper). It is usually combined with digitalis or squill for diuretic action in dropsies of chronic heart and liver disease.

Hydrargyrum cum Creta — Mercury with Chalk — gray pow-

der; mercury 38; clarified honey 10; chalk 57; water q.s. This is a finely divided form of mercury obtained by triturating mercury with clarified honey. Moist chalk is then added. It contains 38 per cent. of mercury, and is useful as a laxative, antacid and alterative. Very useful in diarrheas of young animals, foals, calves, puppies.

Doses. Foals and calves gr. x—xv; 0.6—1. Dogs gr. j—iv; .065—0.3.

Unguentum Hydrargyri. Mercurial ointment. Contains 50 per cent. of mercury.

Unguentum Hydrargyri Dilutum; Diluted mercurial Ointment — Blue ointment; mercurial ointment 600, petrolatum 400.

Mercurial ointment contains 50 per cent. of mercury. It is made very similarly to blue mass. These ointments are quite extensively used as absorbents and in skin diseases but should not be applied over large areas on account of danger from absorption. They are very useful as absorbents in such conditions as synovitis, bursitis, arthritis and glandular enlargements. Mercurial ointment is also a parasiticide but is usually employed as Blue ointment — Unguentum Hygrargyri Dilutum — which contains 30 per cent. of Mercury. Avoid use on cattle as they are said to be very susceptible.

* *Emplastrum Hydrargyri.* Mercurial plaster, contains 30 per cent. of mercury. Used externally as an application for enlarged glands, parasites, eczema.

SALTS OF MERCURY

HYDRARGYRI CHLORIDI CORROSIVUM — CORROSIVE MERCURIC CHLORIDE

Synonyms. Corrosive sublimate, mercuric chloride, bichloride of mercury, perchloride of mercury.

Bichloride of mercury occurs as heavy, colorless, rhombic crystals, or crystalline masses or as a white powder; odorless, permanent in air, and having a characteristic and persistent metallic taste. It is soluble in 13 parts of water, 3, of alcohol and about 12, of glycerin. It may be made more soluble by the addition of hydrochloric, tartaric or citric acid, or ammonium chloride.

Doses. H. & C. gr. jss—iij; 0.1—0.2. Sh. & Sw. gr. ⅙—⅓; 0.01—0.02. D. gr. 1/12—⅙; 0.005—0.01.

Action and Uses. The action of this salt has been previously given. It is used internally as an alterative and tonic; externally as a caustic, antiseptic, disinfectant, parasiticide, resolvent and irritant.

* Unofficial.

1. *Tonic* or *Alterative.* Sometimes useful in addition to iron as a tonic in secondary anemia.

2. *Caustic.* Here it is used as a paste with acacia, 1—1 to 5, or as a caustic solution in alcohol from 1 to 3 to 10, or as a supersaturated solution in water by aid of hydrochloric acid, or applied in pure form.

3. *Antiseptic.* Corrosive sublimate is one of the best antiseptics. It is extremely powerful, solutions as weak as 1—20,000 kill most bacteria and a solution of 1—10,000, most spores. A few organisms such as those of anthrax are more resistant to it. It has, however, several disadvantages; in the presence of hydrogen sulphide it is converted into the insoluble and inert sulphide. It forms impermeable albuminates with the proteids of the tissues which prevents deep action, is irritant to the tissues, corrodes instruments and may be sufficiently absorbed to produce harm if applied too freely to wounds or mucous membranes. In spite of these objections corrosive sublimate is one of the best agents for preparing the field of operation, the hands of the operator and for irrigating infected wounds and cavities, but should not be used in serous cavities because it is too irritant. For the field of operation and the operator's hands a solution of 1—1000 or 1—500 may be used. For large cavities or wounds, 1—10,000 or 5000; for small wounds, 1—2000; for the bladder and vagina, 1—20,000; and conjunctiva, 1—5000. Tartaric or citric acid may be added to prevent the formation of the albuminates with the tissues. Hard water partially precipitates the salt as the oxide but this may be prevented by the addition of an equal amount of sodium chloride.

4. *Disinfectant.* It is useful for stable or other disinfection; may be used as a wash or spray in 1—500 to 1—1000 for this purpose.

5. *Parasiticide.* Solutions of 1—1000 in water or alcohol are very serviceable for ringworm, mange or lice, but must be used with caution on account of absorption and danger from the animal licking it off.

6. *Irritant and absorbent.* Corrosive sublimate is a valuable irritant and absorbent in bony growths, spavin, etc.

℞ Hydrargyri Chloridi Corrosivi ..... 1.
Aquæ ..... 300.
Alcoholis ..... 700.
M. Ft. Sol. Application for hands and operating areas, lice, mange, eczema.

℞ Hydrargyri Chloridi Corrosivi ..... ℥ iv
Acidi Hydrochlorici ..... ℥ jss
Alcoholis ..... ℥ viij
M. et ad,

Alcoholis ..... ℥ xxxvj
Olei Terebinthinæ ..... ℥ vj
Camphoræ ..... ℥ iv
M. Sig. Apply daily with tooth brush for spavin.

℞ Hydrargyri Chloridi Corrosivi .....gr. ij–iv
Iodi.
Glycerini .....āā. ℥ j
Alcoholis q. s. .....ad. ℥ j
M. Sig. Apply every other day with brush for spavin, etc.

℞ Hydrargyri Chloridi Corrosivi 0.8
Acidi Hydrochlorici 60.0
Alcoholis 640.0
M. Ft. Harrington's Solution.
Very powerful skin disinfectant. Sponge surface for two minutes, then wash with alcohol.

℞ Hydrargyri Chloridi Corrosivi ..... ℥ iv
Acidi Hydrochlorici ..... ℥ ij
Aquæ q. s. .....ad. O. ij
M. Ft. Supersaturated solution for caustic injection in fistulæ.

* **Sal Alembroth** is composed of 2 parts of corrosive sublimate to 1 of sodium chloride. This is less irritant than the mercuric salt used alone.

Incompatibles. There is a wide range of incompatibles. Albumen, tannic acid, alkaline carbonates, iodides, silver nitrate, and solutions of lime. It forms mercuric iodide if combined with potassium iodide but if there is an excess of the latter salt a colorless solution of the double salt is formed so that the two may be combined for therapeutic action.

* **Lotio Flava.** Yellow Wash is made by adding 24 grains of mercuric chloride to 16 ounces of lime water. Yellow mercuric oxide is precipitated and calcium chloride is in solution.

HYDRARGYRI CHLORIDUM MITE — MILD MERCUROUS CHLORIDE

Synonyms. Calomel, mercurous chloride, protochloride of mercury, subchloride of mercury.

Calomel occurs as a white, odorless, tasteless powder, insoluble in all ordinary menstrua, permanent in air.

Doses. H. and C. ℥ j—ij; 4.—8. Sheep gr. xv—lx; 1.—4. Dog gr. ss—jss; 0.03—0.1. Cat gr. ⅙—¾; 0.01—0.05.

Preparation: *Pilulæ Cathartice Compositæ.* 1 grain each.

Therapeutics. 1. *Cathartic.* Particularly for the dog and cat but is not suitable for habitual constipation, being specially useful in the early stages of infectious fevers to thoroughly unload the bowels and at the same time serve as an intestinal antiseptic.

* Unofficial.

2. *Intestinal Antiseptic* in distemper, influenza, purpura, etc.

3. *In Diarrhea of the Young to Serve* as an antiseptic and rid the animal of the irritant.

4. *Diuretic* in conditions as mentioned previously.

5. Calomel is also regarded as a *vermicide* for round worms. It is best prescribed with santonin. In this combination each drug seems to aid the other.

6. *Externally.* Antiseptic and desiccant in moist eczema, canker, thrush and foot rot. It is very useful added to zinc oxide ointment in proportion of 5 to 20 grains to the ounce for subacute and chronic eczema. It is probably the best single remedy for the treatment of thrush in horses, and is useful in corneal ulcers and phlyctenular conjunctivitis.

Incompatibles. It is incompatible with chlorates, chlorides, iodides, bromides, and lime water.

* *Lotio Nigra.* Black Lotion. This is made by adding 1 dram of calomel to 16 ounces of lime water. Black mercuric oxide is precipitated and calcium chloride remains in solution. This is useful in acute eczema. It should be daubed upon the parts and allowed to dry. Then follow with ointment of zinc oxide.

HYDRARGYRI IODIDUM RUBRUM — RED IODIDE OF MERCURY

Synonyms. Biniodide of Mercury, Mercuric Iodide

Red iodide of mercury occurs as a scarlet red amorphous powder, odorless, tasteless, slightly soluble in water and in 116 parts of alcohol, but freely soluble in solutions of potassium iodide.

Doses. Very seldom used internally.

Preparation. *Liquor Arseni et Hydrargyri Iodidi.* Donovan's solution. Contains 1 per cent. of each iodide.

Doses. H. and C. ʒij—ℨj; 4—30. D. ♏ ij—x; 0.13—0.6.

Therapeutics. It resembles the bichloride and is almost entirely used externally as an irritant and antiseptic. It is a favorite blister in ointments with lard or petrolatum 1:3—8 or in strong alcoholic solution for diseases of the bones. It is believed that its action extends deeply. It is a strong antiseptic, but rarely used for this purpose.

℞ Hydrargyri Iodidi Rubri.
Cantharidis ..... āā ʒ ij
Adipis ..... ℨ ij
M. Ft. Unguentum.
Sig. Apply to spavin or ringbone. Rub well.

* Unofficial.

℞ Hydrargyri Iodidi Rubri 30.0
Potassii Iodidi 10.0
Tincturæ Cantharidis q. s. ad. 100.0
M. Ft. Sol.
Sig. Apply with cone or swab to spavin, ringbone, etc. Avoid contact with the hands. *Antiperiostin* according to Fröhner.

HYDRARGYRI IODIDUM FLAVUM — YELLOW MERCUROUS IODIDE

Synonyms. Protiodide of Mercury, Green Iodide of Mercury, Mercurous Iodide.

Properties. Bright yellow amorphous powder, odorless and tasteless. By exposure to light it becomes greenish, as it decomposes into metallic mercury and mercuric iodide.

Therapeutics. This is less irritant than the red iodide. Particularly useful in mercurial treatment of syphilis in man.

* HYDRARGYRI NITRAS

This is official as:

1. *Liquor Hydrargyri Nitratis.* (60 per cent. mercuric nitrate and 11, of free nitric acid.)

2. *Unguentum Hydrargyri Nitratis.* Citrine Ointment. (7 per cent. of mercuric nitrate), Mercury 7, nitric acid 17.5, Lard 76.

Therapeutics. The ointment more or less diluted, is used as a stimulant to indolent ulcers, ringworm, chronic eczema, or is applied full strength to ulcers, foot rot, etc.

It is often useful diluted 1—7—8 as a stimulant to chronic eye diseases such as opacities or deposits in the cornea.

For Opacity of Cornea.

℞ Unguenti Hydrargyri Nitratis ..... ʒ j
Oleati Hydrargyri ..... ʒ ij
Adipis Lanæ Hydrosi ..... ʒ iij–v
Sig. Paint on edge of lids once or twice daily.

For Ringworm.

℞ Unguenti Hydrargyri Nitratis ..... ʒ j
Adipis ..... ʒ iv
M. Ft. Unguentum.
Sig. Apply to part twice daily.

HYDRARGYRI AMMONIATUM — AMMONIATED MERCURY

Synonyms. Mercuric Ammonium Chloride, White Precipitate

This salt is made by the action of ammonia upon bichloride of mercury. It occurs as a white, odorless, tasteless, insoluble powder.

Preparation. *Unguentum Hydrargyri Ammoniati* (10 per cent.) in white petrolatum 50, Hydrus wool fat 40.

* Unofficial.

Therapeutics. Externally as a stimulant and parasiticide, in chronic eczema, parasitic skin diseases, etc. In eye salve 1; 10—20. The official ointment is usually too powerful 20 to 30 grains to the ounce is usually sufficient.

* HYDRARGYRI CYANIDUM

Cyanide of mercury occurs as colorless, prismatic crystals, odorless but of a bitter metallic taste. Resembles the bichloride but is less irritant. It does not corrode instruments and is used in surgery as an antiseptic.

HYDRARGYRI OXIDUM FLAVUM AND HYDRARGYRI OXIDUM RUBRUM

Synonyms. Yellow Precipitate, Red Precipitate

Yellow mercuric oxide and red mercuric oxide, yellow and red precipitate respectively occur as insoluble powders. The color depends upon the method of preparation. The uses are identical. They are not used internally.

Preparations.

* *Unguentum Hydrargyri Oxidi Rubri* } 10 per cent in wool fat
Unguentum Hydrargyri Flavi } and white petrolatum.

Oleatum Hydrargyri 25 per cent. of the yellow variety in oleic acid.

Therapeutics. Stimulant and antiseptic to wounds and bruises. The ointments are very useful in eczema, scratches, and in chronic glandular enlargements for absorbent action; as an eye salve, diluted with an equal amount of lanolin and petrolatum or 1:30—50, in leucoma, or other chronic inflammations of the eye. The yellow variety is usually preferred because it is less gritty and makes the better ointment.

℞ Unguenti Hydrargyri Oxidi Flavi..... ʒ iv
Adipis Lanæ Hydrosi.
Petrolati .....āā ʒ ij
M. Sig. For eczema, granular lids, etc.

* HYDRARGYRI SUBSULPHAS FLAVAS

Synonyms. Yellow Mercuric Sulphate, Turpeth Mineral

This occurs as a yellow, odorless and tasteless powder. It was formerly used as an emetic but has been replaced by other drugs.

HYDRARGYRI SALICYLAS

Synonym. Mercuric Subsalicylate

This occurs as a white amorphous powder, odorless, tasteless, insoluble in water or alcohol but soluble in solutions of sodium chlo-

* Unofficial.

ride. Has been recommended for chronic rheumatism, particularly the so called "syphilitic" of man, but is of no importance in veterinary medicine.

MANGANUM — MANGANESE

Manganese is found in traces in the red blood cells and other tissues of the body, for which reason it has been recommended in the treatment of chlorosis and other forms of anemia but the concensus of opinion of most authorities is that it is worthless in these conditions. The soluble salts are not absorbed sufficiently rapid to produce systematic effects and the action of the soluble salts is purely local. The permanganate has been recommended by some as an emmenagogue, but since it is irritating and at the same time decomposed into the black oxide of manganese, this preparation, Mangani Dioxidum Præcipitatum, which is free from irritating effects, is to be preferred. The permanganate is the most important salt and since it is of most service as a germicide it is discussed under that head.

The following salts of manganese are used:

Mangani Dioxidum Præcipitatum. Precipitated manganese dioxide.

Properties: Heavy, very fine black powder, odorless and tasteless, permanent in air, insoluble in water and alcohol.

* Mangani Sulphas.

* Mangani Hypophosphide.

Potassii Permanganas.

* Syrupus Ferri et Mangani Iodidi. N. F.

CHROMIUM

Three preparations of chromium are used in medicine:

Chromium trioxidum, chromium sulphate and Potassium dichromate.

CHROMII TRIOXIDUM — CHROMIUM TRIOXIDE

Synonym. Chromic Acid

Chromium trioxide occurs in the form of small needle shaped crystals or rhombic prisms, of a dark purplish-red color and metallic lustre, odorless, deliquescent in moist air. It is very soluble in water. Decomposition takes place very rapidly when it is brought into contact with glycerin, ether and other organic solvents, often with dangerous violence.

Therapeutics. Chromium trioxide coagulates albumen and is used entirely as a caustic to destroy granulations and pathological tissue, but requires careful handling, as it is liable to cause dangerous

* Unofficial.

wounds. A solution is sometimes employed to wash out poisoned wounds. It is not used internally.

CHROMII SULPHAS — CHROMIUM SULPHATE

Chromium sulphate occurs as dark green scales, soluble in water. It has been recommended in fibrosis of the tissues, such as prostatic hypertrophe, etc., and in some forms of neurasthenia, locomotor ataxia and exophthalmic goiter in man. The results from its use are not conclusive.

Average dose (human) grs. iv—viij; 0.25—0.5.

POTASSII DICHROMAS — POTASSIUM DICHROMATE

Potassium dichromate occurs as large, orange-red, transparent, triclinic prisms or four-sided tabular crystals, odorless, and having an acidulous, metal taste. It is soluble in about 9 parts of water, insoluble in alcohol.

Doses. H. gr. iij—x; 0.2—0.6. D. gr. $\frac{1}{10}$—$\frac{1}{5}$; 0.006—0.012.

Therapeutics. Potassium dichromate is rarely used internally, although Quitman recommends it in the treatment of Purpura Hemorrhagica.

Externally it is used in a saturated solution as a caustic for superficial growths.

Purpura.

℞ Potassii Dichromatis ..... ʒ ij
Tincturæ Ferri Chloridi ..... ʒ iv
Aquæ q. s. .....ad. O. j
M. Ft. Sol.
Sig. One ounce in water every 4 or 5 hours.

ALUMINUM

The only important salt of aluminum is alumen or alum.

ALUMEN — ALUM

Alum is official in two forms: *ammonium alum* prepared by combining aluminum sulphate with ammonium sulphate; and *potassium alum,* prepared by combining aluminum sulphate with potassium sulphate.

Potassium alum occurs as large, colorless crystals, crystalline fragments or a white powder. It is odorless, has a sweetish and strongly astringent taste, soluble in 7 parts of water, more soluble in boiling water, insoluble in alcohol.

Ammonium alum has similar characteristics, but is slightly less soluble in water.

Doses. H. 3 ij—vj; 8.—24. Dog, Astringent, gr. v—x; 0.3—0.6. Emetic, 3j—ij; 4.—8; repeated if necessary.

Preparation. *Alumen exsiccatus,* Dried or burnt alum, alumen ustum. This is ordinary alum from which the water of crystallization has been driven off by roasting.

* *Liquor Alumini Acetatis* — Burow's Solution. N. F.

Action. The action of alum is purely local. Applied to the skin or mucous membranes it is a very strong astringent. It precipitates the proteids of the tissues, coagulates the fluids and constricts the tissues. The precipitate, however, is soluble in an excess of the proteid. It is also antiseptic by reason of its coagulant action. Alum also forms a firm clot with blood, so is hemostatic. Burnt alum is irritant if applied too freely.

Internally therapeutic doses exert no action beyond the digestive tract, where it has a local astringent action and has a tendency to cause constipation. It is not at all absorbed from the digestive tract and large doses cause vomiting and exudative inflammation with purging.

Therapeutics. 1. *Astringent and antiseptic.* Used in 2—5 per cent. solutions for mucous membranes; conjunctivitis, metritis, pharyngitis, stomatitis, etc. Burnt alum is useful as a dusting powder and escharotic for various wounds.

2. *Hemostatic.* Alum is valuable as a hemostatic in small hemorrhages. Dried alum is to be preferred, but forms a heavy scab and is too irritant when used alone.

3. *An astringent internally,* but little used.

4. *Emetic.* Alum is a safe but uncertain emetic. It has been largely superseded by others of more desirable action. One dram in a half cup of tepid water may be used in emergency.

5. *Laminitis.* Douglas, Merrillat and others recommend alum in the treatment of this disease.

Douglas treats hospital cases by limiting the drinking water and administering a 3 to 6 dram dose (bolus) every four to six hours until the symptoms are relieved. In treating "out" cases, he prescribes 6 to 12 ounces of a solution of 1 ounce of alum to a pint of water, to be given every 4 to 6 hours. This treatment may be combined with the subcutaneous injections of adrenalin over the plantar nerves. Campbell recommends 2 ounce doses of alum in a quart of water, every 2 hours until a pound has been given. He precedes this treatment with arecoline, and administers ⅙ grain of aconitine hypodermically, every half hour until the temperature returns to normal.

* Unofficial.

℞ Aluminis ..... ℥ v
Plumbi Acetatis ..... ℥ j
Aquæ ..... ℥ xij
M. Ft. Burow's Solution.

℞ Aluminis Exsiccati ..... 50.
Acidi Borici ..... 50.
M. Ft. Pulver.
Sig. Dusting powder, for wounds, galls, etc.

CHAPTER XXVI

SULPHUR COMPOUNDS

This group contains sulphur, hydrogen sulphide, sulphides, polysulphides, thiosulphite, ichthyol and thiol.

Sulphur occurs in the following three forms, sulphur sublimatum, sulphur lotum and sulphur præcipitatum.

SULPHUR SUBLIMATUM

Synonyms. Sublimed Sulphur, Flowers of Sulphur, Sublimed Crude Sulphur

Properties. Fine yellow powder, slightly characteristic odor and faint acid taste. It is insoluble in water, nearly insoluble in absolute alcohol, ether, chloroform, boiling solutions of alkaline hydrates, oil of turpentine and some other oils.

Preparation.

Unguentum Sulphuris, 15 per cent. in benzoinated lard.

SULPHUR LOTUM

Washed Sulphur

This is the ordinary sulphur washed with ammonia water to remove the free acids.

Preparation.

Pulvis Glycyrrhizæ Compositus, Compound licorice powder, 8 per cent.

SULPHUR PRÆCIPITATUM

Lac sulphur, milk of sulphur. This is made by precipitating a solution of sulphurated lime with hydrochloric acid. It is a fine amorphous powder, of pale yellow color, with other characteristics similar to sublimed sulphur.

Doses of sulphur. H. ʒij—iv; 60.—120. D. ʒss—iv; 2.—15.

Action. Sulphur itself is insoluble in the tissue fluids or digestive secretions and has no action. When administered by the mouth, a large part is eliminated unchanged, but some is converted into sul-

phides, to which the action is due. These sulphides, hydrogen sulphide and others, are irritant enough to account for the mild cathartic following the administration of sulphur and are also the cause of the foul smelling feces and flatus following its use. Externally it is also inert until converted into the sulphides by the secretions from the skin and is then a mild irritant and parasiticide. The conversion of sulphur into the sulphides is always so slow that it has a slow, mild and persistent action. A little is absorbed after conversion as may be demonstrated by an increase in the amount of phosphates in the urine.

Therapeutics.

Externally. It is a stimulant and parasiticide for eczema, mange and ringworm. It is most serviceable when used as an ointment or mixture with oil. The official ointment is often used but *Unguentum Sulphuris Alkalinum N. F.* is probably better, as the alkali aids in dissolving the secretions and penetration of the sulphur.

Internally. Sulphur is a mild laxative. It is very serviceable in prolapse, hemorrhoids, etc., and for young animals.

1.

℞ Sulphuris Sublimati.
Potassii Carbonatis .....āā. 5.
Adipis Benzoinati ..... 20.
M. Ft. Ung. for eczema, etc.

2.

℞ Olei Gossypii Seminis .....O. ij
Olei Picis Liquidæ ..... ℥ iv
Sulphuris Sublimati ..... ℥ iv
Acidi Salicylici ..... ℥ j
Liquoris Cresolis Comp. ..... ℥ j
M. Ft. Linimentum.
Sig. Apply for mange and eczema.

3.

℞ Sulphuris Sublimati ..... 20 lbs.
Calcis ..... 16 lbs.
Aquæ q. s. .....ad. 100 gallons.
Mix the lime into a thin paste with water, add the sulphur, then 25 of water, boil 2 hours, draw off liquid portion and add to it enough water to make 100 gallons.
Lime-Sulphur Dip for mange, etc.

4.

℞ Picis Liquidæ.
Sulphuris Subl. .....āā. ℥ iij
Saponis Mollis.
Alcoholis .....āā. ℥ vj
M. Ft. Vienna Tar Liniment (Fröhner).

5.

℞ Sulphuris Sublim 50
Hydrargyri 5
Pulveris Canthatidis 20
Petrolati 400
M. Ft. Ung.
Sig. For summer mange and acne in horse.

Unguentum Sulphuris Alkalinum, N. F.

℞ Washed Sulphur ..... 20 gms.
Potassium Carbonate ..... 10 gms.
Water ..... 5 mils
Benzoinated Lard ..... 65 gms.

Unguentum Sulphuris Compositum, N. F. (Hebra's Itch Ointment).

℞ Precipitated Calcium Carbonate..... 10 gms.
Sublimed Sulphur ..... 15 gms.
Oil of Cade..... 15 gms.
Soft Soap ..... 30 gms.
Lard ..... 30 gms.

For Sarcoptic Mange.

℞ Unguenti Sulphuris Alkalini, N. F..... 100. gms.
Balsami Peruviani ..... 25. gms.
Saponis Mollis ..... 25. gms.
M. Ft. Unguentum.
Sig. Apply every day for several days, wash and repeat if necessary.

* SULPHURIS IODIDUM — SULPHUR IODIDE

This is made by heating 20 parts of washed sulphur with 80 of iodine, in a loosely closed vessel, over a water bath. It occurs as dark colored brittle masses of crystalline fracture and metallic lustre, iodine odor and acrid taste. It is insoluble in water, soluble in 60 parts of glycerin.

Therapeutics. Always externally. Very serviceable in solution in oil in chronic eczema, ringworms and mange. Used in solution of 1:8—10 in oil and applied daily with a stiff brush.

CALCII SULPHIDUM CRUDUM

Synonyms. Sulphurated Lime, Sulphide of Calcium, Calx Sulphurata, U. S. P. VIII

Properties. Pale gray powder, faint odor of hydrogen sulphide, nauseous and alkaline taste. Slightly soluble in cold water.

Doses. H. gr. xx—lx; 1.3—4. D. gr. $\frac{1}{10}$—$\frac{1}{2}$; 0.006—0.03. Until saturation as shown by sulphide breath and feces.

* Unofficial.

Therapeutics. Some reputation in chronic suppurations as boils, fistulæ, etc. The impure salt is the basis of the lime sulphur dip for mange.

POTASSII SULPHURATA

Synonyms. Sulphurated Potash, Liver of Sulphur, Sulphide of Potash

Properties. Irregular pieces, liver brown when freshly made, changing to greenish brown, greenish yellow and finally to gray, strong odor of hydrogen sulphide and a bitter acrid alkaline taste; soluble in water, insoluble in alcohol.

Therapeutics. Almost entirely as a bath for mange. It may be used on horses in strength of 1 to 30, dogs ¼ as strong, 1 to 100.

SULPHITES

SODII SULPHIS EXSICCATUS — DRIED SODIUM SULPHITE

Dried sodium sulphite occurs as a white powder, odorless and having a cooling saline and sulphurous taste, efflorescent in air; soluble in 3.2 parts of water, slightly soluble in alcohol.

Doses. H. and C. ʒss—j; 15.—30. D. gr. iij—xv; 0.2—1.

SODII BISULPHIS — SODIUM BISULPHITE

Sodium bisulphite occurs as opaque prismatic crystals or a granular powder, exhaling an odor of sulphur dioxide and having a disagreeable sulphurous taste. When exposed to the air, it loses sulphur dioxide and is gradually oxidized into the sulphate. It is soluble in 4 parts of water and 72 of alcohol.

Doses. The same as for the sulphite.

SODII THIOSULPHAS — SODIUM THIOSULPHATE — HYPOSULPHITE

Sodium hyposulphite occurs as a white crystalline powder or as white transparent crystals, odorless, and of a cooling, somewhat bitter taste. It is freely soluble in water, insoluble in alcohol.

Doses. Same as the bisulphite.

Action and Uses. Externally, these preparations are deodorizers, antiseptics and antiparasiticides. The hyposulphite is most used. These preparations are used externally in the treatment of parasitic skin disease. They may be applied in ten per cent. solution for mange and ringworm. Sodium thiosulphate is used to remove iodine and silver nitrate stains. There are no indications for the use of these drugs internally.

* ICHTHYOL

This is a mixture of sulphur compounds obtained by the distillation of a bituminous shale rich in fossil remains of fishes, hence the name, found in Tyrol. It occurs as a thick, dark liquid, of a bituminous odor and taste. It is soluble in water and in mixtures of alcohol and ether, miscible with oils and glycerin in all proportions, but is almost insoluble in strong alcohol and ether. It contains from 10 to 15 per cent. of sulphur, to which its effects are probably largely due.

Doses. H. ʒ ij; 60. D. 3 j; 4. Daily. In capsules or pills.

Action. It is slightly irritant if applied in concentration and is readily absorbed through the unbroken skin if massaged fairly well. It is also antiseptic. Its method of action is in dispute. Internally large doses cause gastrointestinal irritation and diarrhea.

Therapeutics. 1. Skin diseases. Here it resembles sulphur in action and uses. It is very serviceable in eczema and mange, in ointments from 5 to 25 per cent. in strength.

2. Resolvent. It is reported as very efficient in reducing swollen glands and joints. Use same strength preparation as above.

3. As a dressing for burns, sprains, bruises and wounds.

4. Internally. Ichthyol has been recommended in dog distemper, in purpura, etc., but its claims are probably exaggerated.

* ICHTHALBIN

Ichthalbin is a combination of ichthyol with albumin. It occurs as a brownish, odorless, tasteless powder.

Doses. Dog gr. iij—v; 0.18—0.3.

Therapeutics. Recommended as a substitute for ichthyol for both external and internal use, on account of the disagreeable odor and taste of the latter drug.

* ICHTHOFORM

This is a condensation product of ichthyol and formaldehyde. It has been advanced as a substitute for ichthyol, but although odorless, is generally less serviceable.

* ICHTHARGAN

This is a combination of ichthyol and silver, containing 30 per cent. of metallic silver in organic chemical combination. It occurs as a brown amorphous powder, of faint chocolate odor, freely soluble

* Unofficial.

in water. Chiefly used as an injection in gonorrhea of man and diarrhea in foals, grs. xv; 1., with opium or tannin. Externally it may be substituted for silver nitrate.

* THIOL

This preparation was introduced as a commercial substitute for ichthyol, but has not been very satisfactory. It is made by action of sulphur and sulphuric acid upon a hydrocarbon formed by destructive distillation of peat.

Tumenol is a similar product.

* Unofficial.

CHAPTER XXVII

GERMICIDES — DISINFECTANTS

Germicides or Disinfectants are agents which will kill or destroy microorganisms and their spores. They may produce this action by coagulating the albuminous constituents of the organisms (metals and their salts), by oxidizing or deoxidizing the cells (potassium permanganate and the sulphides), or by a specific action against them.

Antiseptics are agents which prevent or hinder the growth of microorganisms, without necessarily killing them. There is little difference between disinfectants and antiseptics. Most antiseptics are disinfectants in strong solution or concentration and all disinfectants are antiseptics in weak solutions.

A few agents are usually classified as antiseptics because they are ordinarily used in sufficient concentration to prohibit the growth of organisms, but too weak to destroy them. The principle antiseptics are boric acid, methylene blue, pyoktanin, etc.

Deodorizers are agents which destroy offensive odors and do not necessarily possess antiseptic or disinfectant properties, although most deodorizers are disinfectants. They produce their action largely by oxidizing or deoxidizing fetid compounds by abstracting hydrogen from them. The most important are chlorine, lime, formaldehyde, charcoal and potassium permanganate.

CLASSIFICATION OF GERMICIDES

Disinfectants may be classified according to their physical or chemical structure, or according to their therapeutic use. For convenience of study they will be discussed in detail under the former head and a therapeutic grouping made later.

The principal agents used as disinfectants are:

1. Heat.
2. Metals and their salts.
3. Benzene derivatives. Phenol group.
4. Aniline derivatives, Pyoktanin, etc..
5. Oxidizers and deoxidizers.
6. Halogen group.
7. Miscellaneous.

HEAT

Heat is probably the most certain disinfectant, and may be employed either dry: flame, hot air; or moist: steam, superheated steam or as boiling water. Incineration is the best disinfectant for litter, dressings and articles of little value.

Steam. Steam may be used either at atmospheric pressure (Arnold sterilizer) or under several pounds pressure, (autoclav). There is nothing except the actual flame which is more destructive to bacteria or more penetrating to fabrics than superheated steam (under 5—15 pounds pressure), which gives a temperature of 220°—230° F. It has been demonstrated that moist heat at 230° F. will kill the most resistant spores in 15 minutes. This is the favorite method for disinfecting surgical dressings. Next in order for dressings comes the Arnold sterilizer in which steam at 212° F. is used. For the best results this should be employed for ½ hour or longer on three successive days (fractional sterilization).

Boiling water is mostly used for disinfecting instruments. If sodium carbonate is added, it will prevent the corrosion of instruments and at the same time raise the boiling point of the water. Liquids which need sterilization (solutions of cocaine, etc.) may be boiled if they are not destroyed by the heat. Dry heat is less effective than moist and the temperature needs to be considerably higher.

Pasteurization is incomplete sterilization, in which most but not all of the organisms are killed. It consists of exposing the liquid to a temperature of about 160° F. for ½ hour. It is employed on a large scale to reduce the number of bacteria in milk.

Cold acts as a preservative, but does not destroy bacteria. On the contrary, it has been found in the case of ice cream that although the number of bacteria will decrease for several days, after a time they will show a marked increase, even when the temperature is below freezing.

METALS AND THEIR SALTS

These combine with the albumen of the bacterial cells and form metallic albuminates. Since they also form the same compounds with the cells of the tissues, they form a hard scab or dense precipitate, do not penetrate deeply, and are soon destroyed by the tissues. Most important are:

Salts of *Mercury* — Bichloride, nitrate, oxide.
Silver, Nitrate and the organic preparations.
Copper, Sulphate.
Iron, Sulphate, subsulphate, chloride.
Zinc, Chloride, sulphate, acetate.
Bismuth, Subiodide, subnitrate.

BENZENE DERIVATIVES — PHENOL GROUP

This group includes phenol, phenolsulphonates, creosote, guaiacol, salicylates, cresol preparations, tar, resorcinol, naphthalene, etc.

PHENOL

Synonyms. Carbolic Acid, Phenic Acid

Phenol is obtained from the fractional distillation of coal tar and subsequent purification, or is made synthetically. It should contain not less than 96 per cent. of absolute phenol. It occurs as colorless, needle shaped crystals, or a white crystalline mass, of a characteristic odor and sweetish burning taste. Upon exposure to light, phenol assumes a reddish tint and consequently should be kept in amber or blue bottles or tin containers. It is soluble in 19.6 parts of water at 25° C. (5 per cent.) or in 9 parts of water (90 per cent.) but is not soluble in strengths between these; freely soluble in alcohol, glycerin, chloroform, ether and oils. Phenol has some acid characteristics, but is really an alcohol of the benzene group.

Doses. H. ʒj—ijss; 4.—10. D. ♏ ¾—iij; 0.05—0.2.

Preparations.

Phenol Liquefactum — Liquefied phenol. This is made by adding 1 gram of distilled water to each 9 grams of liquefied phenol. It contains 87 per cent. of absolute phenol, or 90 per cent. of phenol U. S. P. and was introduced into the pharmacopœia for convenience of dispensing.

Unguentum Phenolis 3 per cent. in white petrolatum.

Glyceritum Phenolis 20 per cent. in glycerin.

Dobell's Solution Liquor Sodii Boratis Compositus, N. F. 3 grams of phenol, 15 grams each of sodium bicarbonate and borax, 35 mils of glycerin, and water to make 1000 mils.

Action on Lower Life. Phenol is a specific protoplasmic poison; it precipitates the proteids, but differs from many proteid precipitants in that it does not form compounds with them, as is shown by the fact that it may be washed out of the precipitate, which remains unchanged. Phenol is a very active antiseptic for most bacteria, but not for their spores. A 1—1000 solution prevents the growth of most bacteria and a 1 per cent. solution is fatal to most pyogenic bacteria, tubercle, cholera, pus producers, etc., but anthrax spores will not be destroyed in 24 hours with a 5 per cent. solution and tetanus spores are almost as resistant. Solutions in fat or alco-

hol have little antiseptic action because phenol has a greater affinity for them than for the water or proteids of the tissues.

External and Local Action. When applied to the skin in concentration, phenol whitens the skin, causing a burning sensation, followed by a slight anesthesia. The blanched skin later assumes a brownish tint and the epidermis is desquamated. This action is due to precipitation of the proteids with which it comes in contact and may be prevented by washing with alcohol or glycerin in which it is very soluble. In weaker solutions phenol is anesthetic and antipruritic. It is absorbed from the intact skin, but more readily from mucous membranes, and paralyzes or depresses the sensory nerve endings. Since phenol coagulates the proteids of the tissues, its action is not deep after single applications, but if kept in contact with the skin for a considerable time local gangrene may result even when dilute solutions (5 per cent.) have been used.

Digestive System. In small doses it is anesthetic and sedative to the stomach, in large doses, a gastrointestinal irritant. Therapeutic doses are converted into phenolsulphonates.

Circulatory System. Medicinal doses have little if any effect. Larger doses first accelerate and then slow the heart. Toxic doses are followed by a marked fall in blood pressure due to cardiac and vaso-motor depression or paralysis.

Nervous System. Therapeutic doses exert no action. Large or toxic doses depress the cerebrum, causing stupor and coma. In animals tetanic convulsions are often seen and are followed by depression, suggesting that the spinal centers are first stimulated and then depressed. Applied locally it is an anesthetic and produces this action by depressing the peripheral sensory nerves.

Respiratory System. The respirations are first stimulated and then depressed by toxic doses. Death is usually due to asphyxia.

Temperature. Temperature is reduced in fevers. Large or toxic doses dangerously lower temperature. Phenol acts on the temperature similarly to the coal tar antipyretics.

Absorption and Elimination. Phenol is absorbed very easily and rapidly from the skin, wounds and mucous membranes. It is eliminated by all channels, but most of it escapes with the urine. A portion is combined with sulphuric and glycuronic acids in the tissues and is eliminated as the double sulphate and glycuronate of phenol; a portion is oxidized into hydroquinone and pyrocatechin. Large doses are followed by smoky urine. Ischuria and albuminuria are common in poisoning.

Toxicology. Acute or corrosive poisoning is rarely seen in animals. Cats are most susceptible to this drug and may be killed from too free use of it as a disinfectant for their quarters. According to Law, from 3 to 4 drops per pound is the minimum fatal

dose for cats, rabbits and dogs; for the ordinary dog, one-half dram. Horses stand relatively much larger doses; three ounces have been given without causing death, yet one ounce is considered as the minimum fatal dose. Much, however, depends upon the dilution in which administered and the amount of food in the stomach. Hoare gives one ounce as the minimum fatal dose for the horse and 15 minims to 2 drams for the dog.

Symptoms of Poisoning. Strong phenol causes salivation, dysphagia, emesis in vomiting animals, intense abdominal pain, due to corrosion, and death in a short time from collapse. If the dose has been too small to produce death by collapse or too diluted to cause corrosion, the symptoms are: salivation, rapid respirations, emesis in vomiting animals, weak rapid pulse, cold extremities, muscular weakness, paralysis and in a short time stupor and death from respiratory or cardiac failure. Convulsions may occur but are not common.

The odor of phenol may be detected on the breath; the urine is dark green or smoky, turns darker on standing and may contain blood.

Lesions. If death is due to the concentrated form of phenol, there will be white eschars on the mucous membranes of the mouth, esophagus, stomach and possibly the intestines. The kidneys may show acute nephritis on account of excretion of the drug through them.

Treatment. The local action may be relieved by the application of alcohol, acetic acid or oils, since phenol is more soluble in them than in the liquids of the tissues. These agents also tend to extract phenol from the tissues as well as to prevent further penetration. In acute poisoning wash out the stomach and administer lime water or syrup of lime to form an insoluble compound. Alcohol and the soluble sulphates have been recommended as antidotes. Alcohol acts only as a solvent and should be washed out at once to prevent absorption, because alcoholic solutions are easily absorbed and also because alcohol does not prevent systemic action. The sulphates are supposed to form insoluble harmless products with the phenol in the alimentary tract, but their action is too slow when given per os and hence they have been recommended for intravenous administration, but Sollmann and Brown found that the combination takes place too slowly to be of benefit, no matter how administered. Nevertheless these agents should be given a trial per os. Demulcents should be given liberally.

Therapeutics.

1. *Caustic.* Strong phenol may be used to cauterize small wounds, like dog and snake bites, sloughing wounds or nail pricks. Its action is not very painful and may be checked with alcohol.

2. *General Disinfectant.* Phenol may be used as an antiseptic or disinfectant for towels, dressings and wounds in from 1—5 per cent. solution. It is not employed as a surgical dressing so much as formerly, because solutions strong enough to be antiseptic are irritant to the tissues. It is not a suitable agent for disinfection of the surgeon's hands because it anesthetizes or benumbs them. Knives and other cutting instruments, which are injured by boiling, may be disinfected by placing them in a strong solution, then in alcohol, and finally in sterile water. Phenol should not be used for prolonged application to a part on account of its liability to cause gangrene. It has been reported that the pustular form of anthrax has been cured by injecting strong solutions of phenol around the base of the pustule. Phenol camphor (Camphor phenique) makes a very good dressing for many wounds. See camphor, p. 87.

3. *Parasiticide.* Phenol is toxic to most parasites, mange mites, fleas, lice, etc. It is particularly serviceable for mange in sheep, ringworm, lungworms, lice, etc., but should not be used upon dogs or cats.

4. *Fistulæ. Phenol and alcohol treatment.* This method of treatment has been given considerable prominence, by some practitioners, in various forms of fistulæ. Liquefied phenol is injected to fill the cavity, is allowed to remain for two minutes, and then washed out with alcohol. The treatment is to be used once in two weeks. Drainage is to be provided for, but the wound is not to be irrigated. Simply wash the outside.

5. *Local Anesthetic.* Phenol is one of the best agents we have for pruritis, in which case it may be used in solution or in ointment.

6. *Antemetic.* Its antemetic action is probably due to its slight anesthetic action upon the stomach. It may be given in very weak solutions or one or two minims may be added to the usual dose of bismuth.

7. *Tetanus.* Phenol is given credit for having a beneficial action in this disease, and it is believed that animals so infected have a special tolerance for it. Bacelli's treatment consists of the subcutaneous injection of phenol several times daily. Animals stand relatively large doses of phenol in this disease, probably partly due to a specific tolerance for it and partly because it is largely precipitated by the tissues and but slowly absorbed. Thirty-six drams of phenol have been given to a horse in this manner within twenty-four hours, without producing toxic action. Various strengths of solution and doses of phenol have been recommended. One dram of phenol in a 5 per cent. solution four or five times daily are usually employed. This treatment has been lauded by some, but the results from its use are not encouraging. In 1911, Bacelli reported the successful treatment of tetanus in man by the

intravenous use of the drug in 2 per cent. solution. Some practitioners administer phenol in the drinking water or in an enema.

8. *Disinfectant.* Phenol is a very useful disinfectant for buildings, runs, etc., in from 3 to 5 per cent. solution. A disinfectant made from equal parts of crude carbolic acid and sulphuric acid is just as efficient and much cheaper than those made from phenol.

Contraindications. Phenol should be sparingly used upon cats and dogs and should not be used as a disinfectant for kennels or catteries. These animals are very susceptible to the drug and may absorb enough to cause disastrous results. It should not be used as a disinfectant for meat markets, meat wagons, milk houses, or wagons, as it is liable to taint the product. This holds good for any of the coal tar disinfectants.

Anesthetic, Pruritis, etc.

℞ Phenolis ..... ʒ ij
Acidi Borici ..... ʒ iv
Alcoholis ..... ℥ j
Glycerini ..... ℥ ss
Aquæ q. s. .....ad. O. j
M. Ft. Solutio.

or

℞ Phenolis.
Camphoræ .....āā. gr. xxx
Ung. Zinci Oxidi q. s.....ad. ʒ j
M. Ft. Unguentum.

Vomiting in Dogs.

℞ Phenolis ..... ♏ ij
Bismuthi Subnitratis ..... gr. x
M. Ft. Pulver No. 1.
Sig. One powder every hour.

or

℞ Bismuthi Subnitratis ..... ʒ ij
Phenolis ..... gr. vj
Tincturæ Opii Camphoratæ ..... ʒ j
Glycerini ..... ℥ ss
Aquæ q. s. .....ad. ℥ jss
M.
Sig. One dram every two hours (Quitman).

Sheep Scabies. Dip.

℞ Crude carbolic acid ..... 1.5 Kg.
Lime ..... 1.0 Kg.
Soft soap ..... 3.0 Kg.
Water ..... 260.0 liters
M. Ft. Emulsion.

Bacelli's Treatment for Tetanus.

℞ Phenolis.
Glycerini .....āā. ℥ j
Aquæ q. s. .....ad. ℥ xxiv
M. Ft. Sol.
Sig. Three ounces subcutaneously every two to four hours.

THE PHENOLSULPHONATES — SULPHOCARBOLATES

The principal phenolsulphonates are those of Calcium, Zinc and Soda.

Sodii Phenolsulphonas is obtained by dissolving phenol in sulphuric acid, and converting this product into a sodium salt. It occurs as colorless, transparent, rhombic prisms or crystalline granules; odorless and having a cooling, saline bitter taste. Soluble in about 4 parts of water, 140 of alcohol and 5 of glycerin.

Dose. H. and C. 3j—viij; 4.—30. Dog, gr. iij—xv; 0.3—1.

Zinci Phenolsulphonas occurs as a colorless, transparent, rhombic prisms or tubular crystals or in granular form; odorless, and having an astringent, metallic taste. Soluble in about 2 parts of water and alcohol.

Dose. One-half that of the sodium salt.

Calcii Phenolsulphonas occurs as white or faintly pinkish-white almost odorless powder, having an astringent, bitter taste. Easily soluble in water and alcohol.

Doses. Same as for the sodium salt.

Action. These salts act like carbolic acid but are practically nontoxic. Sodium and calcium phenolsulphonates are used as intestinal antiseptics but theoretically are of doubtful value because they are excreted unchanged. The zinc salt is astringent as well as antiseptic and is therefore used when a combination of these actions is desired. Just how much they act as antiseptics cannot be stated, but clinical experience points to their usefulness. It has been recommended that they be given in solution for action upon the stomach, and in keratin coated pills for action upon the intestines. They are usually given, however, in the form of compressed tablets, either coated or uncoated. They are frequently combined as in the following prescription:

℞ Zinci Phenolsulphonatis ..... 1 part
Calcii Phenolsulphonatis.
Sodii Phenolsulphonatis .....āā. 2 parts
M. Ft. Pulver.
5 grains to a dog every 2 to 6 hours. 30 to 60 grains to the horse or cow.

The zinc salt is also used as a wash for inflammations of the various mucous membranes as in conjunctivitis, pharyngitis, etc., in solution of 5 grains to the ounce of water.

* **Xeroform.** Tribromphenol-bismuth is a yellow, odorless and tasteless powder containing about 50 per cent. of bismuth oxide. It is insoluble in ordinary solvents.

Doses. Dog grs. x—xv; 0.65—1, several times daily.

Action and Uses. Xeroform is used externally as a dusting powder, internally as an astringent and intestinal disinfectant.

CREOSOTUM — CRESOTE

Creosote is a mixture of phenols, most important of which are *guaiacol* and *creosol,* obtained by the distillation of wood tar, preferably that of the beech (beechwood creosote). It occurs as a colorless or faintly yellow, oily fluid, of a smoky penetrating odor and caustic taste. It is soluble in 140 parts of water and miscible in alcohol, ether, chloroform and the fixed and volatile oils.

Preparations and Doses.

Creosotum. H. ʒj—iv; 4.—15. Dog, ♏ ss—iij; 0.3—0.2.

Aqua Creosoti 1 per cent. D. ʒj—iv; 4.—15.

Action. Creosote resembles phenol in action but it is much less irritant and toxic, although large doses cause all the symptoms of poisoning by that drug. It is eliminated somewhat by the mucous membrane of the respiratory tract and serves as an antiseptic expectorant. It is anesthetic and, like all members of the group, is antiseptic.

Therapeutics. 1. *Expectorant.* It is particularly valuable in chronic or subacute bronchitis with copious purulent exudate. According to Sollmann, it is best administered by inhalation for pulmonary diseases, but he also states that it will hasten the absorption of pleuritic effusions if rubbed on the chest. Creosote has proved of considerable benefit in canine distemper, in which case it appears to act as an intestinal antiseptic as well as expectorant.

2. *Antiseptic.* It may be used as an intestinal antiseptic in chronic gastric and intestinal catarrah. It possesses no advantage over phenol for external use.

3. *Local anesthetic.* Its anesthetic action is employed particularly in human dentistry, to relieve toothache. Inhalations of creosote, one minim to the ounce of hot water, will also frequently allay cough.

* Unofficial.

Creosote may be administered in an emulsion, in capsules, alcohol, or a bitter tincture. The last mentioned vehicle is used to cover the taste of creosote. Compound tincture of gentian is frequently used for this purpose in human medicine.

Chronic Bronchitis, Horse.

℞ Glycyrrhizæ.
Althaeæ .....āā. ℥ iv
Creosoti ..... ℥ v
Aquæ q. s.
M. Ft. Pilulæ No. III.
Sig. One pill daily (Udall).

Intestinal Antiseptic, Horse and Cow.

℞ Creosoti ..... ℥ vj
Cretæ Præparatæ ..... ℥ vj
M. Ft. Chartæ No. XII.
Sig. One every three hours.

Distemper Dog.

℞ Creosoti ..... ℥ j
Emulsi Olei Morrhuæ .....ad. ℥ viij
M. Tere Bene.
Sig. Two to four drams every six hours.

* COAL TAR CREOSOTE

This preparation has been recommended as a vermicide for stomach worms and lung worms in sheep. For stomach worms give the following dosage: Lambs 4 to 12 months old, 2 to 4 drams of a 1 per cent. solution as a drench — sheep 3—5 drams. For lung worms inject intratracheally 5 mils of a 5 per cent. solution in olive oil at intervals of 4 to 5 days. Repeat three or four times. (Udall.)

CREOSOTI CARBONAS — CREOSOTE CARBONATE

Synonym. Creosotal

Creosote carbonate occurs as an oily liquid, containing the carbonates of creosote, chief of which are those of guaiacol and creosol. It is odorless and tasteless or having a slight odor and taste of creosote, is insoluble in water but soluble in alcohol, ether, chloroform and oils.

Doses. About four times those of creosote.

Action and Uses. Creosote carbonate resembles creosote in action but is less irritating to the stomach and is said to be less toxic.

* Unofficial.

GUAIACOL

This is the chief constituent of creosote, from which it is obtained by fractional distillation, or it may be prepared synthetically. It occurs as a crystalline solid or oily liquid of unpleasant aromatic odor and taste. It is slightly soluble in water but soluble in alcohol, ether and glycerin. It unites with acids to form crystalline compounds.

Doses. Twice those of creosote.

Action and Uses. Guaiacol acts similarly to phenol and creosote. It is a powerful antipyretic if applied to the skin and evaporation is prevented, but is very depressant and transitory in action. It has been recommended internally in the same group of diseases as creosote. Quitman recommends it in dram doses in water, repeated in from ½ to 2 hours if necessary, in edema of the glottis. It is claimed that guaiacol will shorten the period of resolution in pneumonia of horses from 2 to 3 days.

GUAIACOLIS CARBONAS — GUAIACOL CARBONATE

Synonym. Duotal

This product is obtained by the action of carbonyl chloride on the sodium salt of guaiacol.

It occurs as a white crystalline powder, of faint odor and taste. It contains 91 per cent. of guaiacol, is insoluble in water, slightly soluble in alcohol, glycerin and oils. It is claimed to be less toxic and better borne than guaiacol, since it is odorless and tasteless. It is used as a substitute for guaiacol in doses about double those of that drug.

Pneumonia of Horse.

℞ Guaiacolis ..... ℥ ij
Glycerini ..... ℥ iv
Alcoholis q. s. .....ad. ℥ xvj
M. Sig. One ounce every three hours.

Chronic Cough, Horse.

℞ Guaiacolis ..... ℥ iv
Olei Lini .....O. ij
M. Sig. One to two ounces three times daily.

Subacute Bronchitis, Dog.

℞ Strychninæ Sulphatis ..... gr. ¼
Codeinæ Sulphatis ..... gr. ij
Guaiacolis Carbonatis ..... gr. xxx
Terebeni ..... ♏ xxx
M. Pone in Capsules No. XXIV.
Sig. Two capsules every 4 hours.

* THIOCOL

Thiocol is potassium ortho-guaiacolsulphonate. It occurs as a white odorless powder of a slightly bitter taste and sweetish after-taste; soluble in water or syrup, slightly soluble in alcohol, insoluble in ether and oils. It is used as a substitute for guaiacol.

PIX LIQUIDA

Synonyms. Tar, Pine Tar

Tar is an aromatic oleoresin obtained by the destructive distillation of *Pinus palustris,* Miller, and other species of pine. It is soluble in alcohol and oils, but almost insoluble in water. Its active ingredients are guaiacols and creosols. When redistilled it separates into a volatile oil and pitch.

Properties. Tar occurs as a semiliquid, viscid, blackish-brown, noncrystalline, translucent, in thin layers, becoming granular and opaque with age; odor empyreumatic, terebinthinate taste, miscible with alcohol, ether, chloroform, and fixed and volatile oils.

Preparations and Doses.

Pix Liquida. H. ʒ ss—j; 15—30. Dog, ♏ xv—lx; 1.—4.

Oleum Picis Liquidæ Rectificatum, a thick dark reddish-brown volatile oil distilled from tar; of strong empyreumatic odor and taste. It is soluble in alcohol. *Doses.* Half those of tar.

Syrupus Picis Liquidæ. Tar 5, alcohol 50, magnesium carbonate 10, sugar 850.

Unguentum Picis Liquidæ. Tar 500, yellow wax 150, lard 350.

Actions. Tar resembles guaiacol and creosote in action, it is an antiseptic, local stimulant, parasiticide and expectorant.

Uses. 1. *Skin diseases.* Tar is used as a stimulant, parasiticide, and antiseptic in various forms of skin disease. It is used as a parasiticide in various forms of mange and as a stimulant in chronic eczema. It should not be used in acute eczema on account of its stimulating action. The general rule for its use in eczema is that the more chronic the case, the more is tar indicated. Even in chronic cases of this disease, its application must be closely watched because many skins will not tolerate it.

2. *Expectorant.* Tar and its volatile oil are favorite expectorants among the laity. They are useful in chronic bronchitis, where they serve the same purpose as their constituents. For representative prescriptions containing tar, see sulphur, p. 440.

* Unofficial.

OLEUM CADINUM — OIL OF CADE

Synonyms. Juniper Tar Oil, Oleum Juniperi Empyreumaticum

This is a tar obtained from the destructive distillation of *Juniperus Oxycedrus,* Linne, of the Mediterranean. It occurs as a thick dark volatile oil of tarry odor and taste. Its action and uses are the same as given for oil of tar, but it is often preferred to this agent on account of its more agreeable odor.

CRESOL PREPARATIONS

There are three cresols, ortho, meta and para, all homologues of phenol. They are obtained by the fractional distillation of coal tar. Cresol, U. S. P., is a mixture of the three, freed from phenol. It occurs as a colorless or straw colored fluid, turning dark brown with age or exposure to light. One mil dissolves in 50 mils of water; it is miscible with alcohol, ether, benzene or glycerin; soluble in solutions of the fixed alkali hydroxides. It is often called "cresylic acid."

Preparations.

Liquor Cresolis Compositus, a 50 per cent. solution in potash or soda soap. This preparation is claimed to be twice as strong an antiseptic as phenol. It is practically identical with Lysol and various other soapy disinfectants.

Formula.

Cresol	500 gms.
Linseed Oil	300 gms.
Potassium Hydroxide	80 gms.
Alcohol	30 gms.
Water, enough to make	1000 gms.

OTHER CRESOL PREPARATIONS

* **Tricresol** is a mixture of cresols: ortho cresol 35 per cent., meta cresol 40 per cent., and para cresol 35 per cent.

* **Creolin** is an emulsion of cresol made by the use of a resin soap. It occurs as a dark brown liquid, of characteristic odor. When diluted with water it makes an opaque or milky liquid. There are many cresol preparations similar to creolin and used interchangeably with it. In general they are less toxic than phenol but should be used with care upon dogs and coats. *Merck's Creolin* (*Creolin Pearson*) is probably the best for internal use and is the least toxic, although many other similar preparations have been used without causing trouble in horses and cattle.

Dose of Creolin. H. and C. ʒss—j; 15—30. Sh. and Sw. ʒj—ijss; 4.—10. D. ♏ v—xx; 0.3—1.3.

* Unofficial.

The preparations of cresol are mainly used as antiseptics, disinfectants and parasiticides. They are used internally as antiferments and gastro-intestinal antiseptics.

THYMOL — THYMIC ACID

Thymol is a homologue of phenol obtained from the oil of thyme (*Thymus vulgaris*) and certain other volatile oils. It occurs in large colorless crystals, with a thyme-like odor and aromatic pungent taste. It is but slightly soluble in water, freely soluble in alcohol, ether and oils.

Doses. Antiseptic. H. 3ss—ij. D. gr. ij—v. Vermicide. D. grs. v—xxx; 0.3—2. Average grs. xv; 1.

Actions and Uses. The action of thymol resembles that of phenol, but it is less toxic and irritant. It has been used as an antiseptic for wounds, but its odor attracts flies and soon becomes distasteful to attendants.

Internally it has been recommended as an intestinal antiseptic, but it is used more extensively as a remedy against the hook worms (Uncinaria) of dogs. Two methods of use have been advanced for the treatment of hookworms. 1. Daily doses of from five to ten grains for a considerable length of time, with an occasional saline purge about once a week, and 2, according to the following plan: Fast the dog for about 12 hours, and give a saline purge at night. Early the next morning administer a large dose of thymol with an equal amount of sugar of milk, in a capsule; two hours later repeat the dose of thymol and milk sugar and in two hours more administer a saline laxative. This treatment may be repeated in from ten days to two weeks. Thymol has also been recommended for the treatment of tape and round worms.

Hook Worms in Dog.

℞ Thymolis.
Sacchari Lactis .....āā. grs. xxx–lx
M. Pone in capsulas No. 2.
One at 6 A. M., the other at 8 A. M. Follow with 1 ounce of magnesium sulphate at 10 A. M.

RESORCINOL — RESORCIN

This is a diatomic phenol occurring as colorless or slightly reddish prisms or needles, having a slight urine-like odor and sweetish pungent taste. It is soluble in alcohol, water and ether.

Doses. H. 3ss—j; 2—4. Dog, gr. ij—v; 0.1—0.3.

Action and Uses. Resorcin is similar to phenol but milder in action and less toxic. It is also an antipyretic, but is not often used

for this purpose. Locally it is antiseptic and antipruritic. Resorcin is most frequently used externally in skin diseases, such as scratches, eczema, wounds, etc., in a 1 per cent. solution or 10 per cent. ointment. A 3 to 5 per cent. solution is very useful in seborrhea, especially with dandruff. In eczema and pruritis it is employed in from 1 to 5 per cent. solution. Sodium chloride is said to enhance its antipruritic action. It may be used internally as an intestinal antiseptic.

Seborrhea.

℞ Resorcinolis ..... ʒ jss
Olei Ricini ..... ♏ xx–xxx
Alcoholis q. s. .....ad. ℥ iv
M. Ft. Sol.
Sig. Apply to parts once or twice daily.

Antipruritic.

℞ Resorcinolis ..... gr. xv–xxx
Sodii Chloridi ..... gr. xv
Liquoris Calcis q. s. .....ad. ℥ iv
M. Ft. Sol.
Sig. Apply to parts daily, or more frequently if necessary.

TRINITROPHENOL

Synonym. Picric Acid

This is prepared by the action of nitric acid upon phenol-sulphonic acid, obtained by dissolving phenol in sulphuric acid. It occurs in yellow, flat odorless scales or crystals of very bitter taste. Slightly soluble in water, soluble in alcohol and ether.

Action. Locally it is a caustic in concentration, turning the skin yellow. It is also a feeble germicide. Internally it is a corrosive poison.

Therapeutics.

Externally. Burns. Minor degrees of burns are treated as follows: Gauze is wet with a 1 per cent. solution of the drug and is applied and covered with cotton. It should not be used over large or deep burns, on account of danger of poisoning. It is also recommended by some in a 1 to 6 per cent. hydro-alcoholic solution as a dressing for moist eczema and scratches.

Internally it has been used as a vermicide for strongylosis and tapeworms of sheep. For this purpose it is given in doses of 1 to 3 grains in mucilaginous drinks.

* NAPHTHALENUM

Synonyms. Naphthalen, Naphthalin, Tar Camphor

This is a hydrocarbon obtained by the distillation of coal tar between 180° and 250° C. It occurs as white shining scales, of a

* Unofficial.

strong coal tar odor and burning taste. It is insoluble in water, soluble in alcohol, ether and chloroform.

Doses. H. 3ij—iv; 8.—15. D. gr. j—xx; 0.6—1.3.

Action and Uses. It has been recommended as an antiseptic dusting powder combined with starch, etc. Internally it is used as an intestinal antiseptic, but has been largely replaced by betanaphthal.

BETANAPHTHOL

This is a phenol occurring in coal tar but mostly made from the preceding drug. It occurs in colorless or pale buff colored shining scales or a whitish yellow or white crystalline powder, of a faint phenol odor and pungent taste.

Doses. Same as for Naphthalenum.

In action it resembles phenol, but is less toxic. It is used as an intestinal antiseptic and probably ranks next to thymol in the treatment of Uncinariasis. It is to be given in 10 to 15 grain doses in capsules and repeated in two hours, preceded and followed by a laxative. It has been advanced as a remedy for skin diseases, but is generally less serviceable than tar.

* BENZONAPHTHOL

This is formed by the action of benzoyl chloride on betanaphthol. It is said to escape the action of the digestive juice. It has the advantage of being soluble and tasteless.

Dose. Dog, gr. ij—vij; 0.13—0.5 every 2 hours.

BISMUTHI BETANAPHTHOLAS

Synonyms. Orphol, Bismuth Oxide plus Betanaphthol

It occurs as a light brown insoluble powder, odorless or with a faint odor of betanaphthol, and tasteless. It is useful in intestinal catarrh, because it is not broken up until after leaving the stomach.

ANILINE DERIVATIVES

Several aniline derivatives have been used as antiseptics, chief of which are pyoktanin, methylene blue, trypan blue and scarlet red.

* PYOKTANIN

Pyoktanin occurs in two forms, blue and yellow. Pyoktanin Blue is chemically Penta et Hexa-methyl-pararosaniline Hydrochloride. It is sometimes called methyl blue or methyl violet, and must

* Unofficial.

not be confused with methylene blue. Pyoktanin blue occurs in the form of small indigo-colored crystals, slightly soluble in water, freely soluble in alcohol.

Action and Uses. This preparation is slightly astringent, antiseptic and analgesic. It is very useful in suppurations of the eye, conjunctivitis, etc., in solutions of from 1—500 to 1—1000 in water. It may be used on open wounds, upon galls, etc., in the same strength solution in either alcohol or water. It is a favorite remedy of horsemen for galls and chafes, upon which it may be used in alcoholic solution or in the form of an ointment. Pyoktanin blue colors the part a deep purple, but this may be removed by rubbing well with soap and water and washing with alcohol. It is not used internally in veterinary medicine.

Pyoktanin yellow occurs as a yellow powder. It resembles the previous variety but is weaker.

Purulent Conjunctivitis.

℞ Atropinæ Sulphatis ..... gr. ij
Pyoktanin Blue ..... gr. j
Aquæ q. s.. .....ad. ℥ j
M. Ft. Sol.
Sig. A few drops in the eye three or four times daily.

For Scratches, Hobble Chafes, etc.

℞ Pyoktanin Blue ..... gr. j
Zinci Oxidi ..... ʒ j
Petrolati ..... ℥ ij
Tincturæ Iodi ..... ʒ ss
M. Ft. Unguentum.
Sig. Apply to parts.

METHYLTHIONINE CHLORIDUM — METHYLENE BLUE

Methylene blue is antiseptic and analgesic. It is eliminated to a great extent by the urine and milk and has been used as a urinary antiseptic. During its excretion it colors the urine green. On account of its elimination through the mammary gland some practitioners have employed it in mastitis with considerable success. Rich recommends it in infectious abortion of cattle in daily doses of 10 grams in capsule or upon the ensilage for 4 or 5 weeks as early in pregnancy as possible. He also employs it as a uterine douche in the same condition, in the proportion of 10 grams of pyoktanin, 30 grams of salt, to a gallon of water. He has given as high as 4 ounces daily.

* **Trypan Blue.** Trypan blue is a complex substance derived from toluidine and amidonaphtholsulphonate of sodium. It has been used with good results in the treatment of piroplasmosis of animals, especially of cattle and dogs. Nuttall used a 1 to 5 per cent. solu-

tion in sterile cold water. Doses are: for small dogs 2 mils (30 minims), large dogs 15 mils (one-half ounce) intravenously or subcutaneously. Intravenous administration is to be preferred on account of liability of abscess formation from hypodermic use. Dose for cattle is 150 mils (5 ounces) to 200 mils (6½ ounces). We have given 100 mils (3½ ounces) of a one per cent. solution to a full grown setter without producing any alarming symptoms. The tissues are all stained blue from injections of this remedy but gradually clear up.

* **Scarlet Red.** Scarlet red is an aniline dye which has only recently been used as a stain.

It occurs as a dark reddish-brown powder, soluble in 15 parts of chloroform, easily soluble in oils, slightly soluble in alcohol and ether and insoluble in water. It has been found useful as a dressing for healthy ulcers and wounds and to promote the proliferation of skin. Hoare says, "It should not be left on longer than 48 hours, or marked irritation will occur." It is employed in the form of an ointment of from 4 to 8 per cent.

Scarlet Red Ointment is a salve containing 8 per cent. of scarlet red, 2 per cent. of oil of eucalyptol and 90 per cent. of petrolatum.

OXIDIZERS AND DEOXIDIZERS

Oxidizers act by liberating oxygen and are quickly destroyed. As a rule they are only medium grade disinfectants but good deodorizers. They quickly destroy many colors and are used as bleaches. Most important are:

Liquor Hydrogenii Dioxidi — Hydrogen peroxide.
Potassii Permanganas — Permanganate of potash.
Sodii Per Boras.
Chlorine.

OXYGENIUM — OXYGEN

Oxygen is a colorless, odorless, tasteless gas, slightly soluble in water and neutral to ordinary indicators. For medical purposes it should be neutral to litmus and free from chlorine or ozone. Oxygen is marketed in cylinders under considerable pressure. The amount of oxygen is usually determined by weight.

Action. In health the inhalation of oxygen has no effect other than to increase the rate of the heart and raise blood pressure.

Therapeutics. Oxygen is used in veterinary medicine almost entirely in the treatment of parturient paresis of cattle and in this condition there is doubt of its being any more efficient than injections of sterile air. In human medicine it is used in conditions

* Unofficial.

of cyanosis, dyspnea and circulatory failure. It is also used in nitrous oxide anesthesia.

Administration. In parturient paresis oxygen is used to inflate the udder. For action upon the circulatory and respiratory systems, the gas is conducted to a mask or tent held over the face or through a tube in the nose and administered by inhalation.

LIQUOR HYDROGENII DIOXIDI

Synonym. Hydrogen Peroxide. $H_2 O_2$.

This is a slightly acid aqueous solution of hydrogen dioxide containing 3 per cent. of the gas by weight and capable of yielding 10 times its volume of oxygen. It is a colorless, odorless liquid, of slightly acidulous taste and produces foam in the mouth, and, on contact with blood, pus and organic material. It is liable to deteriorate with age, exposure to heat and prolonged agitation. If the stopper of the bottle is coated with paraffin or is replaced by a plug of cotton the deterioration is delayed.

Doses. H. ʒ j—ij; 30.—60. D. 3 j—ij; 4.—8.

Hydrogen dioxide is a very powerful, nontoxic, nonirritating antiseptic on account of its readily giving up oxygen when brought into contact with the fluids of the body or pus. When applied to a suppurating wound it effervesces, causing foaming by the liberation of oxygen, the pus is discharged, leaving the wound very clean and protected by a delicate coagulum. There is no effect from its use internally because it is readily converted into oxygen and water in the stomach. Subcutaneously or intravenously it may cause sudden death by gas emboli in the blood. This may also follow its use in serous cavities. A 20 per cent. solution of the official preparation is fatal to most pus organisms and other non-spore bearing ones. Its chief disadvantages are its brief action and liability to deterioration while its advantages are freedom from odor, irritation and toxicity.

Uses. It is particularly valuable in the preliminary treatment of septic wounds, abscess cavities, and fistulous tracts where it acts not only as a disinfectant but also mechanically removes exudates, blood clots, etc. It is either used in the official solution or diluted from 1; 1—3. It should not be injected into deep cavities unless there is free exit as the additional pressure may cause serious results. Furthermore it should not be injected into large serous cavities (peritoneal or pleural). It is a very valuable wash for stomatitis, pharyngitis, etc., for which it should be diluted with two to three parts of water.

POTASSII PERMANGANAS — POTASSIUM PERMANGANATE

Potassium permanganate occurs as slender dark prisms, odorless and of a sweetish astringent taste, soluble in 15 parts of water, decomposed by alcohol.

Incompatibles. It is incompatible with almost everything. It forms explosives with oxidizable substances, especially organic matter as alcohol or glycerin.

Doses. H. 3 ss—j; 2.—4. In pill or drench after meals.
D. gr. ss—j; 0.03—0.065.

Action. If used in pure form or in concentration it is a mild irritant and caustic. If administered in excessive doses it causes all the symptoms of corrosive poisoning. It gives up oxygen in the presence of organic matter and consequently is a germicide and deodorant. Its usefulness, however, is somewhat lessened by its rapid deoxidation which leaves it inert.

Uses. 1. *As a Deodorant and Antiseptic.* In such conditions as stomatitis, fetid ulcers, metritis, etc. in 1 to 2 per cent. solution.

2. *Antiseptic for the Hands.* Use a saturated solution and remove the stain with hydrogen peroxide or oxalic acid.

3. *Poisoning by Morphine or Other Alkaloids.* Potassium permanganate is the chemical antidote for the alkaloids and is generally used in dilute solutions to wash out the stomach. There are no other indications for the internal use of the drug.

* **Acetozone.** (Acetyl — Benzoyl — Peroxide) occurs as a white crystalline powder soluble in 1000 parts of water, in 20 parts of oil, slightly soluble in alcohol, fairly so in ether and chloroform, but slowly decomposing in all of these solvents with the exception of petroleum oil. It also decomposes on contact with organic matter and alkalies. It is marketed only in a 50 per cent. mixture with an inert powder. It evolves hydrogen dioxide in the presence of water. It is usually employed in a solution of 20 to 30 grains to a quart of water, and this may be given in doses of 2 to 5 ounces every few hours to a dog as an intestinal or gastric antiseptic. It may be useful in treating purulent conjunctivitis or keratitis in strengths of 5 grains to the pint of water, or may be employed as a dusting powder, 10 per cent. with boric acid, talcum, zinc oxide, etc.

SODII PERBORAS — SODIUM PERBORATE

This occurs as a white, granular salt, odorless, having a saline taste, soluble in water, and evolves hydrogen peroxide in aqueous solutions. It should contain at least 9 per cent. of available oxygen.

* Unofficial.

It has been recommended as an antiseptic for wounds upon which it may be used as a dusting powder or in freshly prepared solutions.

For the action of chlorine see the group of halogens.

CARBO — CARBON

Carbon is official in two forms, Carbo animalis, and carbo ligni.

CARBO ANIMALIS, ANIMAL CHARCOAL

Synonym. Bone Black

This is prepared by burning bones in closed iron cylinders. It is composed of carbon, calcium phosphate and carbonate. The purified variety has the earthy salts removed by hydrochloric acid.

CARBO LIGNI — WOOD CHARCOAL

This is prepared by partial burning of soft wood. That made from willow is supposed to be the best.

Doses. H. ʒ j—ij; 30.—60. D. ʒ ss—ij; 2.—8.

Charcoal has the power of absorbing many times its volume of gases. It is an oxidizing agent owing to condensation of oxygen in its pores and may serve as a deodorant. Thorough wetting destroys its activity. It is not absorbed so acts locally.

Uses. Charcoal is used externally as a desiccant and absorbent for wounds either alone or combined with other agents. It may be of some service as an absorbent in flatulence but is not very serviceable for large animals.

DEOXIDIZERS

These agents absorb oxygen. Most of them belong to the sulphur or sulphide group, most prominent of which are Sulphur Dioxide, Sulphurous Acid, Sodium Sulphite, Bisulphite and Thiosulphite; Ferrous Sulphate also belongs to this group. These agents are discussed elsewhere.

HALOGENS

The members of the halogen group of drugs used for disinfectants and antiseptics are the free elements chlorine and iodine and those compounds from which they are easily liberated. The halogens enter into combination with all organic matter by withdrawing hydrogen from it and forming the corresponding halogen acid, and at the same time set free oxygen. The halogens are all disinfectant, but bromine and fluorine are not used for this purpose because they are too irritant and corrosive.

Chlorine is generally used in the form of the hypochlorites which easily liberate chlorine. Chlorinated lime (improperly called chloride of lime), bleaching powder, is a mixture of hypochlorites.

Iodine is employed in the free state as the tincture, Lugol's solution, ointment and in various combinations with organic matter of which iodoform may be taken as an example.

Tincture of iodine is a favorite disinfectant for operating areas and infected wounds. For details of the halogens see p. 371.

MISCELLANEOUS DISINFECTANTS

FORMALDEHYDUM

Synonym. Formic Aldehyde

This is a colorless gas formed by oxidizing methyl alcohol. It is official in a 37 per cent. solution in water, under the name of *Liquor Formaldehydi.* Formalin is a similar product. Formalin or solution of formaldehyde is a clear colorless liquid, having a pungent odor and caustic taste. It is miscible in all proportions with water and alcohol.

Action. Formaldehyde is one of the most powerful germicides and has the advantage of being volatile and very penetrating. It prohibits the growth of bacteria in 1: 500 to 1: 20,000 (pure formaldehyde); formalin requires 2½ times as much. It also checks growth in 1: 30,000 of most organisms and solutions of 1: 2½ per cent. kill most bacteria together with their spores, according to species and time of exposure. The gas is more active, in the presence of moisture. It surpasses most disinfectants in penetrating power and does not injure metal or clothing, so is very serviceable for disinfecting rooms, etc.

Formaldehyde vapor is very irritating to the mucous membranes even in dilute solutions but animals and man soon gain a tolerance for it. It toughens the unbroken skin, making it rough and white, and produces anesthesia. Strong solutions or repeated applications may lead to superficial necrosis. These effects are produced by coagulation of the proteids with which it forms actual combinations. It has no effect upon pepsin, rennin or malt but diminishes the activity of papain, trypsin and amylopsin. When inhaled, even for a long time, there is little if any effect aside from some local irritation, which may lead to bronchitis or pneumonia. Intravenous injections of 1: 5000 in physiological saline produce no physiological action. Oral doses have little if any immediate action aside from irritation.

The antidote to local action is ammonia or the ammonium salts. The irritant action of formaldehyde can be largely eliminated by using it in the form of some of its condensation products, from which it is eliminated slowly. It has the property of forming more or less

staple condensation products with many substances, such as proteids (Glutol), carbohydrates (Dextroform, Amyloform), phenols, urea, tannin (tannoform), Ammonia (Urotropin) and polymers (Paraform).

Therapeutics. 1. *Disinfectant.* Formaldehyde has been used for sterilizing dressings and surgical material but on account of its action on the hands, and irritating vapor, has lost favor.

2. *Disinfectant for Rooms and Stables.* Formaldehyde may be used to disinfect rooms in any of the following ways:

a. By soaking sheets in formalin and hanging them in the room.
b. By heating a solution of formaldehyde and thus liberating the gas.
c. By burning paraform candles or heating paraform.
d. The Board of Health of New York City recommends the addition of one pound of fresh quicklime to a mixture of 6 ounces of aluminum sulphate and 8 ounces of solution of formaldehyde for each 1000 cubic feet to be disinfected.
e. Adding potassium permanganate to solution of formaldehyde. The Bureau of Animal Industry recommends the following: For each 1000 cubic feet to be disinfected: add 1 pound of potassium permanganate to 20 ounces of formalin contained in a large metal or enameled vessel.

With all methods of disinfecting with formalin, the rooms should be tightly sealed and the gas allowed to act from 12 to 24 hours. It is more effective in moist air than dry, therefore steam should be provided if possible. Formaldehyde gas does not kill vermin. Rats, guinea pigs, and rabbits have been found alive after many hours exposure. Ammonia almost immediately neutralizes the gas.

3. *Formalin is often Serviceable in Grease Heel* in 0.25 per cent. solution applied under bandage. As a disinfectant for instruments use a 1—2 per cent. solution.

4. *Septicemia and Purpura Hemorrhagica.* McClelland recommends the intravenous use of formaldehyde for the treatment of these diseases. He uses one dram of formalin or solution of formaldehyde to two pints of water.

5. *White Scours.* It has been recommended in the treatment of white scours in calves, and acute gastric tympany of cattle. Some of its preparations are excellent intestinal antiseptics and astringents (Tannoform).

6. *Parasitic Skin Diseases,* especially for those caused by the vegetable parasites; also to disinfect foul wounds.

7. *To Remove Warts.* It is claimed that warts may be removed by rubbing formalin in them with a stick.

8. *Mastitis.* Frost recommends daily doses of 25 to 30 mils of solution of formaldehyde in capsule or milk in the treatment of streptococcic mastitis.

℞ Liquoris Formaldehydi ..... ʒ j
Aquæ Destillatæ q. s. .....ad. O. ij–ijss
M. Ft. Sol.
Sig. For daily intravenous injection for a horse with septicæmia or purpura hemorrhagica.

White Scours of Calves.

℞ Bacterol.
Liquoris Formaldehydi .....āā. ms. xv
Water or Milk ..... O. j
M.
Sig. Give at one dose.

For Collar Galls.

℞ Liquoris Formaldehydi ..... ʒ ss
Sulphuris Sublimati ..... ʒ v
Adipis ..... ʒ v
M. Ft. Ung.
Sig. Apply to parts.

Pruritis.

℞ Liquoris Formaldehydi ..... 1.
Olei Olivæ ..... 10.
M.
Sig. Apply to parts.

PARAFORMALDEHYDUM — PARAFORM

Synonyms. Trioxmethylene — Triformal

Paraform occurs as friable masses or as a white insoluble powder often pressed into tablets. It sublimes slowly at 100° C. and melts at 170° C. If heated under proper conditions it is decomposed into formaldehyde and is used for the disinfection of rooms, 2 grams being required for each cubic meter (35 cubic feet) or about 2 ounces (57 grams) for each 1000 cubic feet.

Paraform also frees formaldehyde slowly at the body temperature so that it serves as a more powerful intestinal antiseptic than betanaphthol, but is irritant. It may be administered to small animals in doses of 3—8 grains every two hours. Larger doses are cathartic while small ones are constipating. It does not cause serious poisoning even in large doses.

* **Glutol.** This is an odorless, nonirritating powder formed by combination of gelatin with formaldehyde. The formalin is liberated by action of the tissues. It is used as a dusting powder upon open wounds where it forms a firm antiseptic scab.

* Unofficial.

HEXAMETHYLENAMINA.— HEXAMETHYLENAMINE

Synonyms. Urotropin — Formin — Hexamethylentetramine, Amninoform, Cystogin

This product is formed by the action of ammonia upon formaldehyde. It occurs as colorless, odorless crystals, having a sweetish taste, afterwards a bitter taste; soluble in 1.6 parts of water, and in 10 of alcohol.

Doses. H. ʒ j—ij; 4.—8. Dog, gr. xv—xxx; 0.3—2.

Urotropin is rapidly absorbed but produces no systemic action. It appears in the urine within a few minutes after administration and if the urine is acid it is partly converted into formaldehyde which produces its usual antiseptic action. Urotropin has no such action in alkaline urine but the effect may be obtained in man at least by administration of acid sodium phosphate to acidify the urine. The drug has also been found in the milk, bile, pancreatic juice, cerebrospinal fluid, blood, saliva, synovial fluids, nasal and bronchial secretions and pleural effusions in man.

Therapeutics. Its uses depend upon its power to liberate formaldehyde which takes place in acid solutions. It is very useful in infections of the genitourinary tract if the urine is acid. Whether the urine of herbivora may be made acid by administration of acid sodium phosphate is questionable. The two drugs should not be given at the same time as they are incompatible. The sodium salt should be given some time previous to the other.

In acid urine it may either increase the acidity until it is irritating or in itself is irritant, causing the usual run of symptoms of irritation of these parts.

There is considerable controversy over its beneficial action in other conditions because although urotropin has been found in so many parts of the body there is no evidence that it will be decomposed into formaldehyde.

* **Citarin** (*Anhydromethylencitrate of Sodium*). A white crystalline powder, of pleasant acidulous taste, soluble in water, insoluble in alcohol, frees formaldehyde in the blood. Used particularly in gout.

Doses. D. gr. x—xv; 0.6—1.

* *Helmintal* (Urotropin Anhydromethylencitrate). Fine colorless crystals, slightly soluble in water, decomposed by alkalies and slowly by dilute acids with freeing of formaldehyde. Uses and doses similar to urotropin.

* **Tannopin** (Tannon), contains tannin 87 per cent., urotropin 13 per cent. It is a brownish tasteless powder, insoluble in water or

* Unofficial.

dilute acids, decomposes slowly in the intestines, so that it has the antiseptic action of urotropin and the astringent action of tannin. Dose same as for urotropin.

* **Tannoform.** This is a similar compound of tannin and formaldehyde. It resembles the action of the preceding drug but is more irritant. According to Fröhner it is the most efficient desiccant antiseptic for new or old wounds. Used alone or with starch. Internally it is astringent and antiseptic.

Doses. H. and C. ʒij—iij; 60.—90.
Dog grs. xv—xxx; 1.—2.

* CHINOSOL

Oxyquinolin Sulphate — Normal Oxyquinilin Sulphate

Chinosol is a yellow crystalline powder, of saffron-like odor and burning taste, is readily soluble in water, slightly soluble in alcohol, insoluble in ether.

Action and Uses. Chinosol is said to be nontoxic. It is somewhat more powerful as an antiseptic than corrosive sublimate or phenol, having been found to exert an antiseptic action in 1—10,000 solutions. On the other hand it is a weaker germicide or disinfectant than phenol or corrosive sublimate. It does not form compounds with the tissues or injure mucous membranes or tissues, but is incompatible with alkalies and salts of mercury and iron. It is claimed not to cause harmful irritation in any strength, to possess analgesic properties and to be a deodorant. It is used particularly as an antiseptic for mucous membranes starting with solutions as weak as 1: 1000 or 2000 and increasing gradually to 1: 500 if the patient will tolerate it. The usual strength recommended is 1: 1000. Much stronger solutions may be employed as a wound dressing. Hobday says that it is somewhat toxic for the cat either from administration per os or from applications to the skin, but that it is not rapidly absorbed from the intact skin of the dog.

ACIDUM BORICUM — BORIC ACID

Synonym. Boracic Acid

Boric acid occurs as a white unctuous powder, or as colorless transparent scales; is odorless, of a faintly bitter taste, is slowly soluble in 18 parts of water, in 15 of alcohol and 4 of glycerin.

Preparations. *Glyceritum Boroglycerini — Glycerite of Boroglycerin.* 30 per cent. of boric acid. This preparation is more soluble in water than boric acid.

Unguentum Acidi Borici. 10 per cent. in petrolatum and paraffin.

* Unofficial.

Action and Uses. Boric acid is a weak antiseptic but not a disinfectant although it destroys some moulds. It is protectant and soothing when applied to inflamed mucous membranes or raw surfaces. The continued use of even small doses internally causes severe gastrointestinal trouble.

Boric acid is used mostly as a wash for irritated mucous membranes, conjunctivitis, cystitis, etc., in from 2 to 4 per cent. solution. The glycerite is a good application for many irritable skin diseases, eczema, etc. Boric acid is frequently used as a dusting powder for wounds, either alone or in combination with talcum or other diluent. Boric acid is somewhat eliminated by the urine and at one time was employed as a urinary disinfectant but its use has been abandoned for more favorably acting drugs.

SODII BORAS — SODIUM BORATE

Synonym. Borax

Sodium borate is a white powder or colorless transparent crystals, odorless, of a sweetish alkaline taste, soluble in 17 parts of water, insoluble in alcohol, but freely soluble in glycerin.

Action and Uses. Borax is a less active antiseptic than boric acid. It may be used as a mild astringent and antiseptic collyrium and as a gargle or mouth wash. It may be used in somewhat stronger solutions for the latter conditions.

Sodium perborate is discussed under the oxidizers, p. 464.

BENZOIC ACID AND THE BENZOATES

ACIDUM BENZOICUM — BENZOIC ACID

This is an organic acid obtained from benzoin or prepared synthetically. It occurs as colorless or almost colorless scales or needles having an agreeable odor and pungent acid taste. It is slightly soluble in water but freely soluble in alcohol.

SODII BENZOAS — SODIUM BENZOATE

Sodium benzoate occurs as a white amorphous, odorless powder, having a sweetish astringent taste, soluble in water and alcohol.

Benzoic acid and the benzoates really belong to the phenol group of antiseptics. They are mild antiseptics and differ from phenol in not being toxic to the central nervous system. They are also antipyretics but are not often used as such.

The benzoates are good preservatives and as such have been used in the preservation of many foods; they have no important uses internally, but may be used as mild antiseptics externally.

THERAPEUTIC CLASSIFICATION OF DISINFECTANTS

General Disinfectants. There are many disinfectants used for general purposes. *For cesspools,* copperas or lime, chlorinated lime, naphthalin and the cheaper preparations of cresol are generally employed.

For Stables. All litter and articles of little value should be burned. Blankets may be disinfected by steam, or boiling, or by soaking in a disinfectant solution. Harnesses, halters, etc., by a disinfectant solution; woodwork after thorough cleaning, by bichloride of mercury, coal tar preparations or formalin. On account of the difficulty in sealing barns and stables the last named preparation is not of great service in many cases.

Surgical Disinfectants. One of the most important uses of germicides or disinfectants is in surgical technique and aseptic or antiseptic handling of wounds. Bichloride of mercury is one of the most popular disinfectants for general use. It is cheap, soluble and very effective but possesses the disadvantages of being very poisonous, corrosive to instruments, irritant to tissues and is readily decomposed into inactive compounds by proteids. It is said that the last mentioned objection may be overcome by the addition of a weak acid (citric or tartaric). For the preparation of the field of operation a solution of 1: 1000 or 1: 500 should be used and preferably in alcohol. See Harrington's solution, p. 431. For large wounds and cavities 1: 10,000—5000 and for small wounds 1: 2000 to 1: 1000. It should not be used on serous surfaces as it is irritant.

Phenol by many is not regarded as being so efficient but nevertheless is widely used. It is particularly destructive to pus organisms. It is soluble, is not very much affected by proteids and only dulls metallic instruments. On the other hand, it is very toxic and has a benumbing action on the hands. It is used in aqueous solutions of from 1 to 5 per cent. upon open wounds and in the pure form for knives and other instruments which are injured by boiling.

Formaldehyde is a very active disinfectant but is too irritating for general purposes. Solutions of from 1 to 2 per cent. of formalin are occasionally used for wounds and a 2 per cent. solution for instruments.

Practical Disinfection of the Hands. There are several methods for disinfection of the hands of the operator. A few will be mentioned. Fürbringer's method is first, to clean the nails well and scrub the hands with soap and water and brush for several minutes, then soak in alcohol for at least one minute, and then plunge into a 1: 500 aqueous solution of bichloride of mercury while still wet. The alcohol aids in removing the soap and grease from the creases of the hands and at the same time favors the penetration of the antiseptic. Another method is to scrub the hands as mentioned

above, then dip them into a warm saturated solution of potassium permanganate for a few minutes or until they are well stained, and then decolorize with a warm saturated solution of oxalic acid.

Weir's Method. Scrub the hands with green soap and brush under running hot water, then clean around and under the nails with soft wood, then make a paste of equal parts of chlorinated lime and sodium carbonate and water, and rub this cream over the hands until all grittiness disappears, which will require about 5 minutes. Push the paste around and under the nails with a sterile piece of orange wood and finally rinse with sterile water. Harrington's solution or the acetone pyxol method may be used if the hands of the operator will stand them.

Field of Operation. It is taken for granted that any necessary shaving will be done before any of the following means of disinfection are employed:

1. Scrub with soap and water, dry with alcohol, apply two paintings of tincture of iodine.

2. Harrington's solution. Scrub the parts, dry with alcohol, apply Harrington's solution with scrubbing for two minutes, wash off with alcohol. A 1: 1000 solution of bichloride of mercury in 70 per cent. alcohol is very efficient.

3. Pyxol, acetone and alcohol method. This method has come into considerable prominence as a disinfectant for the field of operation and surgeon's hands in human medicine, and has been used in veterinary medicine. It consists of sponging the already cleaned surface for two minutes with pyxol 2, alcohol 60, and acetone 40; then rinse in sterile water. The hands should be soaked for the same length of time.

DISINFECTANTS FOR MUCOUS MEMBRANES

Eye. Boric acid, silver nitrate and organic preparations of silver, copper sulphate, yellow mercuric oxide ointment, boric acid ointment, pyoktanin, zinc sulphate, bichloride of mercury.

Nose. Menthol, boric acid, silver salts and those mentioned above, hydrogen peroxide.

Mouth and Throat. Boric acid, silver preparations, hydrogen peroxide, mercuric chloride, ferric chloride, iodine.

Vagina. Iodine, Lugol's solution, creolin, liquor cresolis compositus, phenol, ichthyol, mercuric chloride.

Uterus. Iodine, iodoform, and any of the above.

Urethra and Bladder. Boric acid, zinc sulphate, potassium permanganate, silver preparations.

Rectum. Boric acid, silver salts, glycerin, ichthyol.

Skin Diseases. Tar, oil of tar, oil of cade, balsam of Peru, benzoin, salicylic acid, resorcin, ichthyol, formaldehyde, mercuric chloride, boric acid, sulphur, iodine.

Wounds. Almost any of the antiseptics or disinfectants.

Respiratory Tract. For inhalation volatile oils, turpentine, eucalyptol, camphor, creosote, guaiacol.

For use after absorption on account of elimination through the respiratory mucous membrane, the same agents per os.

Gastro-Intestinal. For action upon the stomach the following may be used: phenolsulphonates, creosote, phenol, salicylic acid, creolin, turpentine and other volatile oils. For action upon the intestines it is necessary for the drug to pass through the stomach unchanged. Sometimes agents are given for this action in keratin or salol coated pills. The best examples of intestinal antiseptics are salol, aspirin, naphtholin, betanaphthol and ichthyol.

Urinary Tract. These agents are to be given per mouth and on account of their elimination through the urine will inhibit or retard the growth of bacteria in the passage. Principal ones are: urotropin, salicylic acid, and its compounds, and the volatile oils of copaiba, cubebs, sandalwood and turpentine.

For Surgical Supplies.

Dry superheated steam is the best for instruments and dressings. The next best is dry heat. Instruments may be boiled or placed in a solution of disinfectant. Repeated boiling spoils the temper of cutting instruments so that it is better to place them in a strong disinfectant. Catgut is sterilized by boiling in cumol which has a higher boiling point than water.

CHAPTER XXVIII

PROTECTIVES

Protectives may be conveniently divided into emollients, demulcents and dusting powders.

Emollients are agents which soften and relax the parts to which they are applied, while *demulcents* sooth and protect the parts. There is no sharp line of division between the two groups as some substances act in both ways. As a general rule, the term emollient is used to specify those substances which are applied to the skin, while the term demulcent is restricted to those applied to mucous membranes. Dusting powders form another group of agents which are applied to the skin for protectant and soothing effect. They should be free from grittiness, dry and insoluble.

EMOLLIENTS

The most commonly used emollients are:

Lard	Expressed oil of almond
Suet	Linseed oil
Wool fat	Petrolatum
Olive oil	Wax
Spermaceti	Glycerin

Emollients have no action except through mechanical means. They relieve irritation of the skin or diseased surfaces by preventing the part from drying, or protecting it from dust, bacteria or gases. They soften the skin by penetrating it and thus relieve tension and pain in inflamed parts. Finally they are used as vehicles and to promote the absorption of other drugs.

ADEPS — LARD

Lard is the purified internal fat of the abdomen of the hog. *Adeps Benzoinatus,* benzoinated lard, is lard to which 1 per cent. of gum benzoin is added as a preservative.

SEVUM PRÆPARATUM — SUET

This is the internal fat of the abdomen of the sheep purified by boiling and straining.

ADEPS LANÆ — WOOL FAT

Wool fat is the purified wool fat of sheep freed from water.

Preparation. *Adeps Lanæ Hydrosus — Hydrous wool fat.*

Hydrous wool fat or lanolin is prepared by triturating wool fat with water. It should contain not less than 25 nor more than 30 per cent. of water.

Wool fat is used as a base for ointments and has the advantage of being miscible with twice its weight of water and is consequently valuable when any aqueous preparation is used in ointment.

OLEUM OLIVÆ — OLIVE OIL

Olive oil is a fixed oil obtained from the ripe fruit of *Olea europœa.* Olive oil is an emollient and protective externally. Internally it is nutritive, demulcent and laxative. It is frequently prescribed as a laxative for dogs and cats. Dogs, 2 drams to an ounce, cats 1 to 4 drams.

OLEUM GOSSYPPII SEMENIS — COTTON SEED OIL

This is a fixed oil expressed from the seed of the different species of *Gossypium.*

It is almost identical in action and uses to olive oil.

OLEUM AMYGDALÆ EXPRESSUM — EXPRESSED OIL OF ALMONDS

This is a fixed oil obtained from the kernels of varieties of *Prunus amygdalus.* It is emollient, protectant and nutrient but is not often used in veterinary practice.

PETROLATUM

Synonyms. Vaseline, Cosmolene, Petroleum Jelly

Petrolatum is a mixture of semisolid hydrocarbons obtained from petroleum. It occurs as an unctuous mass varying in color from yellowish to light amber.

Preparation. *Petrolatum Album — White Petrolatum.*

White petrolatum is petrolatum nearly decolorized.

PETROLATUM LIQUIDUM — LIQUID PETROLATUM

Liquid petrolatum is a mixture of liquid hydrocarbons obtained from petroleum. The U. S. P. recognizes two varieties, heavy and light.

Petrolatum and petrolatum album are only used as ointment bases.

They possess the advantage of not becoming rancid but they are not absorbed through the skin and do not readily penetrate animal and vegetable parasites. Furthermore they are not easily saponified and consequently are difficult to remove.

Liquid petrolatum is similar to several trade named drugs, white albolene, liquid vaseline, petrolax and numerous others. It is used as a vehicle for oily sprays for the nose and throat in man. It is useful as a laxative for dogs and cats. An enema of liquid petrolatum will be found useful to soften hard feces in cases of impactions. See purgatives, p. 237.

PARAFFINUM — PARAFFIN

Paraffin is a purified mixture of solid hydrocarbons usually obtained from petroleum. Paraffin is not often used in veterinary medicine although it may be added to ointments to give them firmness. It is used in human surgery in the treatment of facial blemishes.

CETACEUM — SPERMACETI

Spermaceti is the concrete fatty substance obtained from the head of the sperm whale. It is a bland substance and used only to give consistence or a higher melting point to ointments and cerates.

CERA — WAX

Wax occurs in two forms, Cera Flava and Cera Alba.

Cera Flava, yellow wax is obtained by melting and purifying the honey-comb of the bee. It is commonly called "beeswax."

Cera Alba. White wax is the same substance bleeched by the air and sunlight. Wax is only used to give consistence to ointments or in the preparation of cerates.

GLYCERINUM — GLYCERIN

Synonym. Glycerole

Glycerin is a liquid obtained by the hydrolysis of vegetable or animal fats or fixed oils, purified by distillation. It is a clear colorless liquid, of a thick syrupy consistence, slight characteristic odor and sweetish taste. It is miscible with water or alcohol; insoluble in chloroform, ether, or fixed and volatile oils.

Glycerin is irritant to the skin and mucous membranes due to the abstraction of water from them but when mixed with two or three parts of water is emollient. It is used as a vehicle for other drugs and as a protectant for slight wounds such as cracks and small fissures of the skin. A small amount (1—2 drams in small animals) injected in the rectum will stimulate peristalsis and cause the ex-

pulsion of feces. According to the observations of Hertz, glycerin is an irritant to the anal canal but not to the rectum. Glycerin is slightly antiseptic probably through osmotic action. It is very useful as a solvent for many drugs and as a vehicle for their external application and internal administration.

DEMULCENTS

Demulcents are mucilaginous substances used to sooth and protect mucous membranes. They do this by forming a protective covering over them and thus prevent irritation from the secretions or foreign matter. They are used 1. As a basis for cough remedies, in which case they are soothing and protectant to the pharyngeal mucous membrane. 2. In the treatment of poisoning. They act by coating over the gastrointestinal mucous membrane and at the same time prevent the absorption of most agents. 3. They are added to solutions of irritant drugs to prevent irritation of the stomach. The most important are:

Acacia	Starch
Tragacanth	Glycyrrhiza
Linum	Althæa

ACACIA

Synonym. Gum Arabic

Acacia is the dried gummy exudation from a tree *Acacia Senegal* and other African species of acacia. Insoluble in alcohol, slowly but almost completely soluble in twice its weight of water forming a mucilaginous liquid.

Preparations. *Mucilago Acaciæ*—Mucilage of acacia.

Pulvis Cretæ Compositus. Compound chalk powder.

Uses. Acacia is used as a demulcent and excipient to hold emulsions, mixtures, etc.

TRAGACANTHA — TRAGACANTH

Tragacanth is the spontaneously dried gummy exudation from the stems of *Astragalus gummifer* or other species of *astragalus.*

Tragacanth is used similarly to acacia. On account of its insolubility it is used to hold heavy oils and powders in suspension.

LINUM — LINSEED

Linseed is the seed of the common flax. When unground it forms a mucilage with water. When ground and mixed with two or three times its weight of boiling water it forms a fairly firm mass which is used as a poultice (flax seed poultice).

AMYLUM — STARCH

Synonym. Corn Starch

Amylum is the starch separated from the grain of *Zea Mays.*

Starch occurs in the form of a fine white powder or in friable white masses. It is insoluble in cold water or alcohol. When mixed with boiling water it forms a transparent gelatinous mixture. Starch is used as a dusting powder and protective in erythema and chafing. Since starch is decomposed by the heat and moisture of the tissues it is better to add boric acid to it as a preservative. Starch poultice or jelly is sometimes used to soften and remove crusts in chronic inflammations of the skin. Starch water is a soothing injection in irritations of the rectum. It is prepared by mixing about a teaspoonful of starch in 2 ounces of water and boiling until the mixture becomes translucent. Then dilute with water to make one pint, or it may be prepared by boiling the starch with the total amount of water at the outset.

GLYCYRRHIZA — LICORICE ROOT

This is the root of *Glycyrrhiza glabra typica* (Spanish licorice) or *Glycyrrhiza glabra glandulifera* (Russian licorice).

Preparations and Doses.

Glycyrrhiza.
Extractum Glycyrrhizæ Purum. Pure extract.
Fluidextractum Glycyrrhizæ.
Mistura Glycyrrhizæ. Brown Mixture.

Doses. Dog, 3 j—ijss; 4.—10.

Licorice is a very feeble drug. It is a popular remedy for coughs and colds in which case it serves as a demulcent. It is more largely used to cover the disagreeable taste of other drugs.

The following substances are occasionally used as demulcents:

Sassafras Medulla	— Sassafras pith
Umulus	— Slippery elm bark
Althæa	— Marshmallow.

DUSTING POWDERS

Dusting powders are used to protect the skin. Some remedies are applied as dusting powders for their antiseptic properties but they are not included in this group. The most important are:

Talcum	Zinc Oxide
Kaolin	Chalk
Starch	Magnesium carbonate
Lycopodium	

TALCUM PURIFICATUM — PURIFIED TALC

Synonyms. Talc, Venetian Talc, Magnesium Silicate, Soapstone

Talc is only used as a protective and diluent.

℞ Talci Purificati ..... ʒ iv
Acidi Borici ..... ʒ j
Zinci Oxidi ..... ʒ iij
M. Ft. Pulver.
Sig. Use as a dusting powder for erythema.

* KAOLINUM — KAOLIN

Synonyms. Fuller's Earth, Hydrated Aluminium Salicate

Kaolin is the principal ingredient of the clay poultices. It occurs as a dirty gray powder or in hard lumps (white rock), is unctuous and slippery when moist, swells up on the addition of water and retains large amounts of water. It may be used in its dry condition as a protectant powder and when soaked up with water or glycerin as a poultice in inflammatory conditions and as a pack for horses' feet.

LYCOPODIUM

Lycopodium is the spores of *Lycopodium claratum.* It may be used as a protective in irritations of the skin and is used in pharmacy as a coating for pills so that they will not stick together.

COLLODIUM — COLLODION

Collodion is a solution of gun cotton in ether and alcohol.

Preparations.

Collodium Flexile. Flexible collodion.
* *Collodium Stypticum.* Styptic collodion.
Collodium Cantharidatum. Cantharidial collodion.

Flexible collodion is a simple protectant, styptic collodion a styptic dressing and cantharidial collodion a mild stimulant.

SOAPS

Two soaps are official, Sapo and Sapo Mollis.

SAPO — SOAP

Soap is directed to be prepared from olive oil and sodium hydroxide. It is really sodium oleate. It corresponds to the "pure white Castile soap" of commerce. It is used as an excipient for making pills, as a detergent, in the preparation of liniments and in preparing enemata. A small piece of soap formed into suitable shape will make a fairly satisfactory suppository for small animals.

* Unofficial.

SAPO MOLLIS — SOFT SOAP

Synonyms. Green Soap, Potassium Oleate

This is made by the action of potassium hydroxide upon cotton seed oil. It is more readily soluble in water than the preceding drug and is consequently often used in making enemata. Soft soap is also a parasiticide and antiseptic and is used in various mange remedies to aid the penetration of other drugs and for the action of the soap itself. Tincture of soap is an alcoholic solution of soft soap.

CHAPTER XXIX

DIAGNOSTIC AGENTS

Two diagnostic agents in common use will be briefly discussed. They are:

Tuberculin and Mallein.

TUBERCULIN

Tuberculin is the concentrated liquid, usually glycerinated bouillon, on which tubercle bacteria have grown until the products resulting from their multiplication, including the disintegrated bodies of dead tubercle bacteria, have become imparted to the medium in sufficient quantity to inhibit their further development. (Moore.)

Action. Tuberculin is harmless to healthy animals in the doses necessary for diagnostic purposes and produces no symptoms in these animals. In tuberculous animals it causes a rise of temperature which follows a fairly definite course and usually terminates within 18 to 24 hours after its administration, but sometimes persists for a longer period of time. After subcutaneous doses of tuberculin, the temperature of tuberculous animals usually begins to increase in from 6 to 8 hours, giving a steady gradual increase for from 2 to 4 hours, followed by a continuous high elevation for a few hours and then gradually returns to normal. In rare cases the elevation of temperature does not take place until 18 or more hours after the injection. Besides the elevation of temperature, animals sometimes show an " organic reaction " manifested by a nervous chill or muscular trembling.

Doses. The dose of tuberculin varies with the concentration used. The average adult dose is 0.25 mil of the concentrated Koch tuberculin but this is made up in various dilutions by different manufacturers. The dose of that prepared at the New York State Veterinary College at Cornell University is 2 mils, and this should be varied according to the weight of the animal.

Methods of Use.

Subcutaneous
Ophthalmic
Intradermal.

Subcutaneous. This consists of injecting tuberculin beneath the skin of the animals and noting the temperature before and after

injection. Usually two preinjection temperatures are taken at 2 and 4 hours previous to the injection, and in some places, a morning temperature is required. The temperatures are resumed in from 6 to 10 hours after the injection and taken at regular intervals up to the 18th hour following the injection or until the temperature returns to normal. The reaction has been explained previously.

Ophthalmic. This is carried out by applying some tuberculin to the conjunctival sac. The reaction consists of a conjunctivitis which begins in cattle in from 5 to 10 hours with watering of the eyes, redness of the conjunctiva and edema followed by a purulent conjunctivitis. The reaction may persist for 1 or 2 days.

Intradermal. In this method the tuberculin is injected into the deeper layers of the skin, usually in one of the folds of the skin on the under side of the base of the tail. The dose is 0.1—0.2 mil. The characteristic reaction is shown by a thickening of the fold of skin or the appearance of a sensitive swelling at the site of the injection. The swelling can be recognized in from 6 to 12 hours and continues to increase for 2 to 3 days. Haring recommends that the observation be made at the 72nd hour if but one is made.

MALLEIN

Mallein is used in the diagnosis of glanders. It consists of the glycerinated bouillon on which glanders bacteria have grown and in which are the products resulting from their multiplication. (Moore.) It is used in two ways:

Subcutaneous
Ophthalmic.

Subcutaneous Method. The usual dose, 0.5—2 mils according to concentration, is injected under the skin on the side of the neck. The reaction consists of a hot painful swelling at the point of injection which shows in a few hours and may increase in size for 24–36 hours. Simultaneously with the swelling, the patient becomes dull, listless, has no appetite and is subject to tremors. This is known as the "organic reaction."

The temperature begins to rise in about 8 hours and gradually rises to 1.5° or more above the normal, usually reaching the maximum between the 10th and 12th hour, and does not return to normal from 24–48 hours or even longer.

Ophthalmic Method. Mallein is applied to one eye of the animal. The reaction begins in from 5 to 6 hours after the application and persists for 36–48 hours longer. It consists of a suppurative conjunctivitis. The results are interpreted as follows: *Moore.* 1. Reaction is positive if a suppurative secretion is observed in varying quantities. If the secretion is present in only small quantities it is

principally visible at the inner canthus of the eye. 2. The reaction is negative in the absence of any secretion. 3. The reaction is doubtful when there is present a slimy secretion or lachrymation after 24 hours.

For complete discussion of these products, see texts on pathology and medicine.

CHAPTER XXX

BACTERINS, SERUMS, VACCINES AND ANTITOXINS HISTORICAL

The present trend of medicine is toward prophylaxis. It is tending toward the old Chinese custom which gave the physician a fee when the patient was well but as soon as he fell sick the payments stopped. The doctor was paid for keeping his patients in good health. Biological products in the form of vaccines, serums and antitoxins have been and are widely used as prophylactic as well as therapeutic agents. The history of the application of these far antedates modern medicine. Hippocrates taught that that which could produce disease was also capable of curing it, a theory which underlies modern homeopathic medicine. Pliny, the Elder, recommended the livers of mad dogs as a cure for hydrophobia. In Asia and other Oriental countries the custom of exposing people to mild forms of smallpox in order to render them immune was practised for many centuries before the discovery of smallpox vaccination.

It remained for Edward Jenner in 1793 to demonstrate in a scientific manner that cow pox, conveyed to man a definite immunity against small pox. This discovery was based on the observation that milk maids who had contracted cow pox in the natural pursuance of their occupation were thereafter immune to small pox.

Very little progress along these lines was made for eighty years or until modern bacteriology began its development. The master scientific mind of Pasteur thought out and developed several of the most important discoveries in the field of vaccination that have ever been made. The first was in relation to fowl cholera. Many of the chickens around Paris were dying from a virulent infection and Pasteur isolated the causative organism, *Bact. choleræ gallinarum.* It was found by accident that cultures of this organism could be attenuated by cultivation so that they were not capable of producing the disease. It was further noted that fowls that had been injected with this non-virulent culture did not succumb when later they were inoculated with a dose of a virulent strain of these bacteria. This furnished Pasteur with the key to the knowledge of active immunization and he had the genius to apply his discovery to the prevention of disease. To this great man of science we owe our present system of immunization against anthrax and rabies. The original methods Pasteur employed in the prevention of these two scourges of man and

beast, are used today, after an interval of nearly fifty years, with but very minor modifications. The next most important discoveries were those of diphtheria antitoxin in 1890 by von Behring and tetanus antitoxin in 1892 by von Behring and Kitasato. Wright and Douglass, in 1903, further advanced the methods of vaccination for therapeutic purposes by injecting dead bacteria into the bodies of patients suffering from infections due to these particular organisms. At first this method which is the basis of our modern "bacterin therapy" was used only in chronic infections but now its application has been extended to include the acute infections, notably typhoid in man and with more or less success in dog distemper, hemorrhagic septicemia and contagious abortion of cattle, etc. Serum of animals immunized to the cause of a disease has been used for some time both as therapeutic and prophylactic agents. The most notable examples of the use of these agents are in cerebrospinal meningitis of man and in hog cholera. The former was put on a firm basis by the experimental studies of Flexner in 1905–6. The latter was discovered and put into application by Dorset, Niles and McBride in 1908. The far reaching success of the use of these agents cannot be expressed in exact figures.

THEORIES OF IMMUNITY

In order to understand the action of the products or agents to be later described, a brief description of the theories of immunity is necessary. For a full discussion of this subject the student or practitioner is referred to the reference books given at the end of this chapter.

Immunity is the resistance to the invasion of a certain organism or cause of disease which is possessed by an individual or animal. In other words, it is the power an animal has to ward off or resist a disease. Immunity is either *natural* or *acquired.*

Natural Immunity. Certain species of animals do not, under natural conditions, succumb to some diseases. For example, cattle are not affected with glanders, dogs with anthrax or horses with black leg. Natural immunity is the resistance certain species of animals have to certain diseases, this resistance being born with the individual. Many theories have been devised to explain this phenomenon but none of them are very satisfactory.

Acquired Immunity is a resistance against disease brought about by a variety of means. (a) Recovery from a naturally contracted attack of the disease. (b) By injecting the individual with living but attenuated cultures or virus. (c) By injecting the individual with fully virulent cultures or virus in sublethal amounts. (d) By injecting dead bacteria and bacterial extracts. (e) By injecting bacterial products (toxins). (f) By injecting the blood

serum of an animal which has recovered from the disease or which has been highly immunized to the virus or cause.

Among the theories elaborated to explain acquired immunity the following should be mentioned:

1. **The Exhaustion Theory.** This was Pasteur's own theory of the mechanism of acquired immunity. He believed that the living microorganism of a disease in an infected animal used up some substance essential to its existence, so that for lack of proper nourishment, the organisms or bacteria were forced to retire, the soil being unfit for further development.

2. **The Retention Theory.** Chauveau, on the other hand, considered it more probable that the microorganism after having lived in the body of an infected animal, produced substances which, accumulating in the blood, had an inhibitory action on the bacteria and caused them to die off. This was really just the opposite to the belief of Pasteur.

3. **The Phagocytosis Theory.** This was the product of the genius of Metchnikoff. He showed that certain cells of the body, particularly the polynuclear leucocytes, were very active in the defense of the body against invasion by microorganisms. According to this theory, these cells ingested or devoured invading bacteria in a manner similar to that of an ameba ingesting a food particle. After being ingested, the cells disposed of the bacteria by intracellular digestion through the agency of ferments known as " cytases." To cells which possess such protective properties the term " phagocyte " is applied and to the process of actual ingestion of the organisms, the term " phagocytosis." This theory was still further elaborated by Wright and Douglas, who showed that certain of the body fluids, notably the blood serum, possessed the property of lowering the resistance of bacteria, rendering them more susceptible to phagocytosis. To that substance which rendered bacteria more " palatable " to the phagocyte Wright gave the name " opsonin."

4. **The Humeral Theory.** This theory is based on the observations of Buchner and others that blood *serum* has the power of destroying a certain number of bacteria when introduced into it.

5. **Ehrlich's Side-chain Theory.** This is really one explanation of the Humeral Theory of immunity but was advanced in 1885 to explain the process of nutrition. Ehrlich believed that cells have two important functions: (a) a special physiologic function, as that of a gland cell to secrete; (b) a function of nutrition and presiding over the process of waste and repair. The second function or that concerned with nutrition is of more importance in relation to immunity. According to his belief the cells have a number of chemical groups or side chains. Immunity depends upon the presence or absence of certain substances which he calls receptors or lateral chains.

Kinds of Immunity. *Toxic Immunity* is where the disease is

caused by an extracellular toxin, such as is produced by *Bact. diphtheriæ* and *B. tetani* and in which the animal or individual is immunized either by the production of an antitoxin within the body due to an attack of the disease or where the antitoxin is injected into the body.

Bacterial immunity is where amboceptors or immune bodies are present having been produced in the body by the influence of the infecting organisms or introduced from without.

An *active* and *passive immunity* are also generally recognized. An active immunity is produced when the specific antitoxin or immune bodies are produced within the body itself. As for example, a dog that recovers from distemper is not susceptible to that disease because the tissues of its body have elaborated and thrown off specific immune bodies toward this infection. Passive immunity is where the individual received from without a sufficient quantity of antitoxin or amboceptors with which to neutralize the toxin or destroy the invading bacteria. As for example, the horse which receives subcutaneously an injection of tetanus antitoxin is rendered passively immune to tetanus. As a rule active immunity is of much longer duration than passive.

Terms Defined. A somewhat vague and not altogether uniform terminology is used in the description of the various biological products employed in the prevention and cure of disease. For this reason it is thought best to include a list of these terms in common usage with their meaning as used in this chapter.

Vaccines. This term comes from the Latin word "vacca," relating to the cow, and in its original application was used by Jenner to designate the prophylactic agent to immunize against smallpox, i.e., the virus of cow pox or "vaccinia." This was a living, attenuated virus. Following the discoveries of Pasteur, Wright and many others, a large number of agents came into usage for immunilogical or therapeutic purposes. These too were termed vaccines. In order to avoid confusion it seems logical to limit the term *vaccine* to apply only to those viruses which are in the living, attenuated form used to produce an active immunity.

Bacterin. This term sprang up in connection with products used for the treatment of disease following the discoveries of Wright, Douglas, Leishman and their colleagues. They are really bacterial vaccines and are called such by many authorities. They consist of dead bacteria and the products of their growth, suspended in sterile physiological saline solution to which is usually added a little disinfectant, as carbolic acid or tricresol 0.1—0.5 per cent. The objection to this term (bacterin) is that it implies an extract of bacteria, as does tuberculin. This objection does not, however, seem to be well founded.

Antitoxin. This is the blood serum of an animal which has

been immunized to the specific toxin, as for example, tetanus antitoxin is the blood serum of an animal which has been immunized with gradually increasing doses of tetanus toxin or which has recovered from tetanus. Most of the antitoxin on the market is in a concentrated form. It is prepared by precipitating the globulin fraction of the raw serum with ammonium sulphate and redissolving it in a minimal quantity of salt solution. The globulins carry with them most of the active principle of the antitoxin and in this manner a serum may be concentrated so that a large number of units may be contained in a small bulk of fluid.

Serums. The serums are the blood serums of animals which have been immunized to the viruses or causes of the diseases for which they are used. It is in this respect, i.e., the animal immunized to the virus instead of the toxin, that they differ from antitoxins noted above. In certain diseases, notably hog cholera, the specific cause is not known, but the virus occurs in the blood of the animals sick with the disease. (Further, it is not known whether there is specific toxin produced by the cause.) Therefore, the animal is immunized to the cause itself as contained in the blood from the infected animal. This product (anti-hog-cholera serum) as now usually manufactured contains the leucocytes and red blood corpuscles as well as the serum.

In case of other serums, such as those for white scours and streptococcic infections, they consist of the serum only of the animals which have been immunized to the bacteria found in cases of white scours and pure cultures of streptococci.

Serobacterins. These are sensitized dead bacteria. Bacteria are immersed in the blood serum of an animal which has been immunized to that specific germ. After sensitization they are washed free of the serum and are suspended in saline solution.

VACCINES

The more important vaccines are used in immunizing against anthrax, rabies and black leg. More recently, Hardenburg has used a vaccine in Hemorrhagic Septicemia of cattle and Bland has also employed one in the control of contagious abortion.

Anthrax Vaccine. (Pasteur.) The usual method of immunization against anthrax consists in the subcutaneous injection of attenuated cultures of *Bact. anthracis.* Two injections of varying degrees of strength are made at intervals of 12 to 14 days. The first injection consists of 1 mil of a bouillon culture of *Bact. anthracis* which has been attenuated by incubation at 42°—43° C. (Optimum incubation temperature 37.5° C.) for a sufficient time to decrease its virulence to a point where it will kill white mice but will not kill guinea pigs. This period of incubation usually takes about 24 days. A culture so attenuated can be used for the preparation of

anthrax vaccine for long periods of time, as it does not seem to regain its virulence. The second injection consists of a culture similarly made and likewise incubated at the high temperature of 42°—43° C. for a period of 12 to 18 days or until its virulence has been reduced to a point where it will kill guinea pigs but not rabbits. When such attenuated cultures are injected into animals, a very mild and usually clinically unnoticeable attack of anthrax is produced which confers an active immunity.

Recently Eichhorn, working in the Bureau of Animal Industry, has developed what is termed a "spore vaccine." It is prepared by first attenuating cultures by growing them at 42.5° C. for varying periods. The cultures which had been grown at the high temperature for 20 days proved satisfactory. The test inoculation showed that their virulence was such that they would kill mice and guinea pigs but not rabbits.

These cultures should be inoculated onto a peptone-free agar medium and grown at a temperature of 37.5° C. for 4 to 7 days, by which time an abundance of spores will have formed. The growth is then washed from the slants and collected in a sterile flask and heated at a temperature of 60° C. for one-half hour, to destroy the vegetative forms of the organism. A measured quantity of this suspension can then be plated out in the usual manner and the spore content of 1 mil of the suspension established. A dilution can then be made to the desired amount for inoculation purposes. Thus, if it is desired to use for vaccination 1,000,000 spores, it is best to dilute the vaccine to a quantity of which 1 mil would contain this number. Of such vaccine 1 mil would constitute the dose for cattle and horses, with correspondingly smaller doses for calves and sheep.

In all forms of vaccination against anthrax in sheep the greatest care must be exercised, since these animals are very susceptible to the disease, and at times vaccines which have no ill effects on cattle will prove fatal to sheep; therefore the dose of the spore vaccine for sheep should not be more than one-fourth the amount given cattle.

In the preparation of spore vaccines it is essential to submit every lot to a test for pathogenicity by inoculating approximately 250,000 spores — that is, 0.25 mil of the standard suspension — into guinea pigs and rabbits before employing the same for vaccination purposes. The guinea pigs should die in from 2 to 5 days, whereas the rabbits should remain alive.

In consideration of the keeping qualities of the spore vaccine, large lots can be prepared without fear of deterioration. In the bottling and storing of the same, however, proper care should be taken to prevent contamination.

This spore vaccine is often used in connection with an anthrax serum. That is, the so-called simultaneous treatment is employed. This consists in injecting an animal with a dose of the spore vaccine

and at the same time with blood serum taken from a horse which has been highly immunized to the anthrax organism. This simultaneous method seems to give very good results.

Rabies Vaccine. Pasteur observed that the virulence of the virus of this disease was less in animals that had been dead for some time than in those just killed, and by experiment he found that when the nervous system of an infected rabbit was dried in a sterile atmosphere, its virulence attenuated in proportion to the length of time it was dried. A method of attenuating the virulence was suggested to Pasteur and the idea of using it as a protective vaccination soon followed.

It is necessary to have for the purpose of vaccination a virus of known or standard virulence. This is prepared from the so-called " street virus," which is usually taken from the brain of a rabid dog. An emulsion is prepared from this material and injected into a rabbit. As soon as this animal dies, its spinal cord is removed, a similar emulsion made from a small piece of it, and a second rabbit inoculated and so on through a series of from 21—30 rabbits or until a standard virulence is attained and the virus is said to be "fixed." This " fixed virus " has a much higher degree of virulence than the " street virus " taken from a rabid dog and its virulence does not vary, always killing rabbits on the sixth or seventh day.

TABLE I

SCHEME FOR MILD TREATMENT

Day	Cord	Amount injected		
		Adult	Five to ten years	One to five years
	Injections	mils	mils	mils
1	8–7–6 = 3	2.5	2.5	2.0
2	5–4 = 2	2.5	2.5	1.5
3	4–3 = 2	2.5	2.5	2.0
4	5 = 1	2.5	2.5	2.5
5	4 = 1	2.5	2.5	2.5
6	3 = 1	2.5	2.5	2.0
7	3 = 1	2.5	1.5	2.0
8	2 = 1	2.5	2.0	1.0
9	2 = 1	2.5	2.5	1.5
10	5 = 1	2.5	2.5	2.5
11	5 = 1	2.5	2.5	2.5
12	4 = 1	2.5	2.5	2.5
13	4 = 1	2.5	2.5	2.5
14	3 = 1	2.5	2.5	2.0
15	3 = 1	2.5	2.5	2.0
16	2 = 1	2.5	2.0	1.5
17	2 = 1	2.5	2.0	1.5
18	4 = 1	2.5	2.5	2.5
19	3 = 1	2.5	2.5	2.5
20	2 = 1	2.5	2.5	2.0
21	2 = 1	2.5	2.5	2.0

TABLE II

SCHEME FOR INTENSIVE TREATMENT

Day	Cord	Amount injected		
		Adult	Five to ten years	One to five years
	Injections	mils	mils	mils
1	8–7–6 = 3	2.5	2.5	2.5
2	4–3 = 2	2.5	2.5	2.0
3	5–4 = 2	2.5	2.5	2.5
4	3 = 1	2.5	2.5	2.0
5	3 = 1	2.5	2.5	2.0
6	2 = 1	2.5	2.0	1.5
7	2 = 1	2.5	2.5	2.0
8	1 = 1	2.5	1.5	1.0
9	5 = 1	2.5	2.5	2.5
10	4 = 1	2.5	2.5	2.5
11	4 = 1	2.5	2.5	2.5
12	3 = 1	2.5	2.5	2.0
13	3 = 1	2.5	2.5	2.0
14	2 = 1	2.5	2.5	2.0
15	2 = 1	2.5	2.5	2.0
16	4 = 1	2.5	2.5	2.5
17	3 = 1	2.5	2.5	2.5
18	2 = 1	2.5	2.5	2.0
19	3 = 1	2.5	2.5	2.0
20	2 = 1	2.5	2.5	2.5
21	1 = 1	2.5	2.5	2.0

A series of spinal cords taken from rabbits dead of "fixed virus" are cut into segments and suspended in sterile glass jars containing caustic potash. These jars are kept at approximately 22° C. The cord, when taken out at the end of the first 24 hours, is found to be almost as active as the fresh untreated cord; the cord removed at 48 hours, is slightly less active than that removed 24 hours before; and the diminution in virulence, though gradual, progresses regularly and surely until at the end of the eighth day the virus is inactive.

The system of treatment given at the different laboratories varies. Some allow the cord to desiccate for 14 days. The system given here is the one used in the Hygienic Laboratory of the Public Health and Marine Hospital Service, Washington, D. C. It also corresponds closely with that used in Berlin.

Black Leg Vaccine. To Arloing, Cornivin and Thomas belongs the honor of first discovering that animals may be protected against black leg by inoculation with more or less virulent material obtained from animals which have died from black leg. They found that hypodermic injection of minimal doses of fluid from a black leg tumor did not necessarily result in death, but frequently produced a mild attack of the disease, unaccompanied by any swelling, and that animals thus treated were afterwards possessed of a very high degree of resistance to the disease. The method of preparing black leg vac-

cine as used by the Bureau of Animal Industry is as follows: Prolonged exposure to a high temperature serves to attenuate the virulence of either fresh or dried virus. The material used for the vaccine is obtained from fresh black leg tissue (which contains *B. chauveaui,* the cause of the disease) by pounding the muscle tissue in a mortar with the addition of a little water and squeezing the pulp through a piece of linen cloth. The juice is spread in layers on plates and is dried quickly at a temperature of about 35° C. This temperature does not in the least affect the germs and the dried virus obtained in this way retains a high degree of virulence for two years or more.

When vaccine is to be prepared, the dry material is pulverized and mixed in a mortar with two parts of water, until it forms a semifluid homogeneous mass. This is spread in a thin layer on a saucer or glass dish and placed in an oven, the temperature of which can be regulated and kept from 90° to 94° C. It should remain at this temperature seven hours. When removed, it appears as a brownish scale, which is easily detached from the dish. The scale is pulverised and put up into packages of 10 doses each. Before it is used, it is mixed with 10 mils water, filtered and the filtrate injected in doses of 1 mil.

An agent which is termed Black Leg Aggressin is also used for immunization against this disease. It is prepared by first chopping up fine black leg muscle. This is then frozen solid for several weeks, then thawed out and the juice pressed out. This liquid is then passed through a Berkfeld filter. It is administered subcutaneously.

BACTERINS

Among the first to employ "heat sterilized" virus for the production of immunity in animals, was the "Father of veterinary medicine in America," Dr. James Law, who in 1880 reported to the U. S. Commissioner of Agriculture that he had been able to immunize pigs to "swine fever" by this agent. He, in time, was followed by Salmon, who immunized pigeons against *B. suipestifer.* Later Moore obtained similar results in guinea pigs with dead bacteria, and these were reported to the Washington Biological Society in 1893. In 1894 Smith and Moore published the results of several series of inoculations with heated cultures of hog cholera and swine plague bacteria. It was not, however, until 1903, due to the work of Wright and Douglass, that this phase of Bacteriology received the impetus which today places it in first rank in therapeutic and prophylactic medicine. According to the work of these men, immunity is produced through the agency of opsonins, which increase the phagocytosis. They also devised a method for estimating the power of the blood serum to prepare bacteria for ingestion by the phagocytes and

called this the "opsonic index." This is not used as much as formerly because its accuracy is not as great as believed by its discoverers.

The method of preparation of bacterins is simple. They are usually made by growing the bacteria on slant agar for a suitable period of time (24—72 hrs.) and washing off the growth with physiological salt solution. This suspension is then sterilized by heating at 55°—60° C. for an hour, diluted so as to contain the proper number of bacteria per mil and a disinfectant added, usually 0.5 per cent. carbolic acid or 0.2 per cent. trikresol.

The method usually employed for counting the bacteria is one devised by Wright. This consists of a comparison of the number of bacteria in a certain quantity of blood. Another method is by the use of the hæmacytometer.

There seems to be no fixed rule or method by which the exact dose can be determined. The response to the initial dose cannot be known in advance of the injection. After the first injection is made and the effect noted, the dose may have to be increased or decreased accordingly. The number of bacteria injected at one time varies from 10 million to 200 billion, the average being 500 million to 1 billion.

In connection with bacterin therapy, several terms are used, the exact meaning of which should be thoroughly understood.

Autogenous bacterins (vaccines) are those made from the same strain of the germ as that causing the disease. Cultures are made from the sick animal and are incubated and bacterins made from these.

Stock bacterins (vaccines) are made from cultures kept in the laboratory.

Polyvalent bacterins (vaccines) are those prepared from more than one strain of some species of bacteria.

Mixed bacterins (vaccines) contain more than one species of bacteria as *B. coli, Ps. pyocyaneus, Mic. aureus,* etc. It has sometimes been compared to the "shot gun" prescription.

The number of bacterins used in the treatment of disease is very large. The most common are strepto- and staphylo-bacterin; B. coli, pneumonia or influenza bacterin and mixed bacterin. Also a bacterin for contagious abortion and dog distemper is on the market.

The administration of bacterins for prophylaxis is in many cases attended with good results. This is especially true in the most excellent results secured in typhoid immunization in man. The therapeutic action of these agents in certain cases of chronic suppuration is undoubted. However, we agree with Eichhorn, who states as follows:

"There is a tendency at the present time to employ bacterins for almost every infection. They are being prepared against most of the pathogenic organisms producing disease, irrespective of whether they

are beneficial or not. At times exaggerated claims are made for such products, and the veterinarians are very apt to make use of them, regardless of whether the cases are adapted to that form of treatment.

"This applies especially to the bacterial vaccines, which, at the present time, have gained such great popularity with the veterinary profession. Polyvalent, mixed, strepto, staphylo, colon, etc., bacterins, are injected into animals at times without any basis for such treatment. I do not intend to condemn any of these preparations, but I desire to strongly advise veterinarians to use good judgment in the selection of such preparations, since in using biological products there is more or less an inclination to disregard or neglect other means of treatment, which would probably benefit the animals far more than a useless injection of an inert product for the particular case."

ANTITOXINS

The two antitoxins in general use are Tetanus and Diphtheria, the former only being used in veterinary practice.

Tetanus Antitoxin. Several methods are used to produce antitoxin, the details of which vary but slightly. The first thing necessary is an active toxin. This is produced by growing *Bacillus tetanus* (in the preparation of tetanus antitoxin) in bouillon cultures anaerobically for from six to ten days. The culture fluid is then *filtered through porcelain and the germ-free filtrate* is used for the inoculation. The horse receives 5 mils as the initial dose of a toxin of which 1 mil would kill 100 guinea pigs each of 350 grams weight. This amount of toxin is injected along with twice the amount of antitoxin required to neutralize it. In five days this dose is doubled and then every five to seven days larger amounts are given. After the third injection, the antitoxin is omitted. The dose is increased at first slowly until appreciable amounts of antitoxin are found to be present and then as rapidly as the horse can stand it, until 700—800 mils of the toxin can be injected at one time. This amount should not be injected in a single place or severe local and perhaps fatal tetanus may develop. This treatment should continue over several months until the blood of the animal contains sufficient antitoxin.

Antitoxin unit. The method of standardizing the antitoxin is to determine its protective action on guinea pigs of standard weight (350 grams) when injected with a toxin of a known strength. A tetanus antitoxin unit is ten times the least amount of serum (from the immunized horse) necessary to save the life of a 350 gram guinea pig for ninety-six hours against 100 minimal lethal doses of a precipitated toxin prepared most carefully and under standard conditions, by the Hygienic Laboratory of the Public Health and Marine-Hospital Service.

Dose. The dosage of tetanus antitoxin varies. An immunizing dose for a horse is usually from 500—1500 units. The therapeutic dose ranges from 5000—20,000 units.

The injection of an antitoxin into an animal establishes a passive immunity differing from that produced by the use of vaccines or bacterins. It is an efficient prophylactic agent, but its therapeutic value is somewhat doubtful.

SERUMS

Anti-Hog-Cholera Serum. The method of preparing this product as given by Birch is as follows:

Process of serum preparation. Immunize a large hog by giving it 2 mils of virus and sufficient serum to protect. After it has recovered from the slight resulting reaction (in ten days or more) it is ready to hyperimmunize at any subsequent time.

Hyperimmunization. Inject the immune hog intravenously with 5 mils of the virus for each pound of body weight. This completes hyperimmunization and the animal is ready to bleed for serum in about ten days.

Bleeding for serum. This is done under antiseptic conditions from the tail, by cutting off the end. Five mils for each pound of body weight is the usual amount drawn. When the bleeding is finished ligate the tail securely.

Handling the blood. Immediately after blood is drawn it is defibrinated, and strained through sterile gauze. For each 90 mils of blood there is added, as a preservative, 10 mils of a 5 per cent. solution of phenol. This completes the process of preparation, and the blood, or serum as it is called, is stored in a refrigerator until a test is to be made. Then the combined bleedings from several hogs are mixed in a large container and a sample is drawn for testing.

Testing the Serum. Eight young susceptible pigs, weighing from 30 to 60 pounds each, and preferably from the same litter, are chosen for the test. All are exposed to hog cholera by giving them 2 mils each of virus. Two of the pigs receive 10 mils each of the serum sample to be tested, two receive 15 mils each, and two receive 20 mils each of the same sample. Two are given no serum and serve as checks. The pigs are marked for identification, placed together and given like care. The requirements of a satisfactory test are that the pigs receiving virus and no serum shall sicken inside of seven days and reach a dying condition inside of fourteen days; and that they shall, on post-mortem, show marked cholera lesions; that the pigs receiving virus and 10 mils of serum shall remain well or sicken and recover; that the pigs receiving virus and the larger doses of serum (15 and 20 mils each) shall not show any clinical symptoms of hog cholera except a moderate and transient rise in temperature.

Use. Anti-Hog-Cholera Serum is primarily a prophylactic agent. However, it has been used in the early stages of the disease as a therapeutic agent with good results. There are two ways in which it may be used.

(a) *Serum alone method.* This consists in administering intramuscularly the necessary dose of serum. The immunity produced thereby lasts a month to six weeks. It is a passive immunity.

(b) *Simultaneous method.* This includes giving a small dose of the virulent hog cholera blood along with the necessary dose of the serum. These two agents are to be injected separately and into different parts of the body. This method produces a permanent immunity in all swine except sucklings.

White Scours Serum. The specific cause of this infection still seems to be in doubt. According, however, to the uniform results of bacteriological studies, the disease in most cases seems to be due to *B. coli* or one of its virulent varieties. It was with this fact in mind that Jensen treated a horse with dead and living cultures of the colon bacillus and prepared a serum which had a decided bactericidal action. This, however, was prepared from a single strain of the colon organism and consequently the monovalent serum was effective only against this particular strain of *B. coli.* Consequently a polyvalent serum was prepared, which proved much more satisfactory.

In the preparation of polyvalent colon serum, carefully selected strains of the colon bacillus are separately cultivated in bouillon at 37° C. Then the cultures are mixed in measured quantities and the mixture is injected intravenously in horses in quantities of 0.25 to 0.50 mils and after each 12—14 days, increasing doses up to 10—20 mils. If after a certain time, the serum of the horse produces precipitation in a bouillon culture of a certain colon strain in the dilution of 1—500 or 1—2000, it is probable that the protective serum may be utilized with satisfactory results against infections with that particular strain. The dose of serum prepared in this manner is from 5—20 mils.

Another white scours serum is being prepared in this country in which different strains of *B. abortus* (Bang) is used in connection with the different strains of *B. coli* for immunizing the horse from which the serum is to be obtained.

Anti-Streptococcus Serum. This is prepared by injecting a horse with gradually increasing amounts of killed cultures of *Strep. pyogenes* obtained from several different sources. Several months elapse before the animal is ready for bleeding. The blood serum is usually preserved by the addition of a small quantity of some disinfectant. This serum may be used in cases of pyemia, septicemia and suppuration due to streptococci. The dose varies between wide limits of from 10—100 mils, depending entirely upon conditions. A polyvalent streptococcus serum has been used with good results in the

treatment of purpura hemorrhagica. This serum originated with Jensen at Copenhagen.

Black Leg Serum. A serum for Black Leg or Symptomatic Anthrax is used in certain parts of the country. It is made by immunizing a horse to gradually increasing doses of *B. chauveui.* This serum is sometimes used in connection with the vaccine in a manner similar to that described under anthrax. It really constitutes a simultaneous treatment. It is also used alone for therapeutic purposes.

SERO BACTERINS

These products originated with Besredka, who in 1902, working at the Pasteur Institute, Paris, brought forward what he termed "Virus-vaccine sensibilis." This was prepared by mixing immune serum and bacteria, permitting the mixture to stand for a while and then centrifuging the bacteria out of the serum and washing them entirely free by repeated centrifugalization with saline solution. The bacteria attract to themselves the specific antibodies which the immune serum contains, and are thus "prepared for digestion by the complement as well as for immediate phagocytosis."

In preparing these agents, the growth from an agar culture of the organism is washed off with saline solutions and the suspension kept at 60° C. for one hour, in order to kill the organisms. This is filtered through fine silk into sterile centrifuge tubes and the corresponding immune goat serum is added. The mixture is left at laboratory temperature for 24 hours. More saline is now added and the mixture centrifuged. The supernatant fluid is poured off and the process repeated until the bacteria are washed free of serum. They are then counted by Wright's method and standard suspensions made up. It is claimed that these agents have a very rapid action, producing a high grade of active immunity within 24 hours after the first injection, with simultaneous marked improvement in the condition of the patient.

Use. As yet they are not very widely used in veterinary practice, but the strepto- and staphylo-sero-bacterins are occasionally employed, also a sero-bacterin for dog distemper.

PHYLACOGENS

These agents are comparatively new and are based on the work and experience of Dr. A. F. Schafer of California. It is his belief: "That all infections are mixed infections," that except in rare instances, there is no such thing as an infection by a single species of microorganism, that while one species may predominate the pathologic process engendered by it is accelerated and intensified by the presence of organisms of other species; in other words, that in the course of an infectious disease, the symptoms are due not only to the

effects of a single species of organism (the specific infection) but to the influence of other organisms whose pathogenic rôle is not insignificant, but which must be reckoned with, in any successful scheme of therapeutics. The preparation of phylacogens is as follows:

"They are sterile, aqueous solutions of metabolic substances or derivatives generated by bacteria grown in artificial media. The bacteria first killed, are removed by filtration through porcelain. To determine sterility, the phylacogens are subjected to careful cultural tests.

"The phylacogens are made from a large variety of pathogenic bacteria, such as the several staphylococci, Streptococcus pyogenes, Bacillus pyocyaneous, Diplococcus pneumoniæ, Bacillus typhosus, Bacillus coli communis, Streptococcus rheumaticus, Streptococcus erysipelatis, etc. This basic Phylacogen is a 'polyvalent' preparation or Polyphylacogen, since the organisms are not from one strain only of a given species, but *from cultures made at frequent intervals and from a variety of sources.* The various organisms are present in the material before filtration and dilution in approximately equal proportions. The cultures are incubated at 37° C. for 72 hours or longer, after which a preservative consisting of 0.5 per cent. of phenol is added to the fluid, which is then filtered through porcelain. The basic phylacogen, made in this manner, is used in the preparation of the several specific phylacogens. It has been named Mixed Infection Phylacogen.

"Each specific phylacogen is prepared as follows: The basic material (Mixed Infection Phylacogen) is modified by the addition of an equal amount of the filtrate obtained by growing and treating the organism considered to be predominant in the pathological condition to be treated; for instance, in the preparation of typhoid phylacogen, the Bacillus typhosus is grown and treated like the several organisms entering into the preparation of the basic Mixed Infection Phylacogen. The filtrate obtained from the preparation of the typhoid organism alone is added in equal amount to the Mixed Infection Phylacogen, and the resulting product given the specific name "Typhoid Phylacogen." A similar method is employed in the manufacture of the other specific phylacogens, such as pneumonia, gonorrhea, tuberculosis, erysipelas, etc., etc."

In veterinary medicine, two phylacogens are now used. They are mixed infection phylacogen and pneumonia phylacogen prepared from Diplococcus pneumonia.

Use. These agents on account of their "polyvalent" character should be used with great caution by the veterinarian. As was pointed out in the use of Bacterins, there is a tendency to use a biological agent whether it has any definite relation to the disease or not. "Shot-gun prescription" biologics are not to be recommended any more than "shot-gun prescriptions" using drugs.

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