

## TRIBASIC ACIDS.

*Tribasic Acids*, having three carboxyl (COOH) groups in the molecule.—*Tricarballic Acid*, or propane-tricarboxylic acid,  $C_3H_5(COOH)_3$ , is the first of this series; its hydroxy-derivative, *citric acid*,  $C_3H_4(OH)(COOH)_3$ , (hydroxy-propane-tricarboxylic acid), found in fruits, has already been described (see p. 323).

## OTHER POLYBASIC ACIDS.

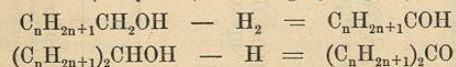
*Tetrabasic Acids* (as pyromellitic acid,  $C_6H_2(COOH)_4$ ) and *hexabasic acids* (as mellitic acid,  $C(COOH)_6$ ) are known.

## QUESTIONS AND EXERCISES.

791. Give general methods for the formation of aldehydes and acids.
792. How is acetaldehyde prepared?
793. Describe the reactions that occur in the manufacture of chloral and chloral hydrate.
794. What is the nature of the action of alkalies on chloral hydrate?
795. Mention the characters of pure and impure chloral hydrate.
796. What relation has valerianic acid to amylic alcohol?
797. Give the relations between the acetic and lactic series of acids.
798. To what series do the following acids belong:—Oleic, butyric, oxalic, and citric?
799. How is benzoic acid prepared? Give the differences between balsam of Peru, Tolu, and gum benzoin.
800. How is oil of bitter almonds prepared, and how can it be distinguished from so-called artificial oil of bitter almonds?
801. Give artificial methods of preparing salicylic aldehyde and acid.
802. Give the systematic names of tartaric, succinic, carbonic, salicylic, and citric acids.

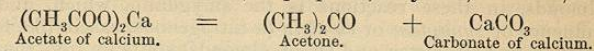
## KETONES.

Just as primary alcohols on losing hydrogen yield aldehydes, so secondary alcohols (see p. 438) on losing hydrogen yield ketones:—



Like aldehydes, ketones are converted by nascent hydrogen into the corresponding alcohols. Like aldehydes, ketones form crystalline compounds with acid sulphites. While, however, aldehydes by oxidation yield corresponding acids, ketones break up and yield acids whose molecules have a smaller number of carbon atoms.

*Acetone*,  $C_3H_6O$ , or *dimethyl-ketone*,  $(CH_3)_2CO$  or  $CH_3.CO.CH_3$ , the original and best known of the class, may be obtained by strongly heating acetate of calcium, carbonate of calcium remaining. The calcium salts of other fatty radicals split up in a similar manner (hence perhaps the name, from *κῆω*, *keō*, to split, and the original *acetone*), yielding other ketones, as propione, butyrone, valerone, etc.



*Note.*—There are many organic substances the composition of which has been established, and the characters of which are definite, whether basic, acid, or neutral, but whose constitution is still so questionable that they cannot yet be classified with the hydrocarbons and derivatives of hydrocarbons. These are the glucosides, alkaloids, albuminoids, certain coloring-matters, etc. They are described in the following pages.

## THE GLUCOSIDES.

*Source.*—The Glucosides are certain proximate vegetable principles which, by ebullition with dilute acid or other method of decomposition, take up the elements of water and yield glucose, accompanied by a second substance, which differs in each case according to the body operated on. Several of the glucosides which are of pharmaceutical interest will now be considered. Tannin, or tannic acid, is also a glucoside; it has been described among the acids.

There are indications that all glucosides may be regenerated from the bodies into which they are converted by heat.

*Note on Nomenclature.*—The first syllable of the names of glucosides and neutral principles generally are commonly given in allusion to origin; the last syllable is *in*, which sufficiently distinguishes them as a class.

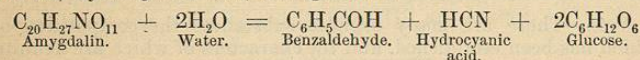
**AMYGDALIN** ( $C_{20}H_{27}NO_{11}, 3H_2O$ ).—This body, obtained by Robiquet and Boutron-Charlard in 1830, was the first discovered glucoside (Liebig and Wöhler, 1837). It is a white crystalline substance, existing in the bitter (*Amygdala Amara*, U. S. P.) but not in the sweet almond (*Amygdala Dulcis*, U. S. P.). About 2 per cent. is readily extracted by strong alcohol from the cake left when the fixed oil has been expressed from bitter almonds. From the concentrated alcoholic solution ether precipitates the amygdalin.

Make an emulsion of two or three sweet almonds by bruising and rubbing them with water, and notice that it has no odor of essential oil of bitter almonds; add a grain or two of amygdalin: an odor of essential oil of bitter almonds is at once developed. Bruise two or three bitter almonds and rub with



water; the volatile oil is again developed (*Oleum Amygdalæ Amaræ*, U. S. P.). Sp. gr. 1.060 to 1.070.

*Bitter-almond water* (*Aqua Amygdalæ Amaræ*, U. S. P.) is made by filtering a mixture of 1 part of the oil with 999 parts of distilled water. The source of the benzaldehyde, or essential oil of bitter almonds, in these reactions is the amygdalin, which, under the influence of *synaptase* or *emulsin* (a nitrogenous, casein-like ferment existing in both bitter and sweet almonds) splits up into the essential oil, hydrocyanic acid, and glucose:—



As each molecule of amygdalin yields one of hydrocyanic acid, a simple calculation shows that 17 grains (mixed with emulsion of sweet almonds) will be required to form 1 grain of real hydrocyanic acid—a quantity equivalent to 50 minims of the diluted hydrocyanic acid of the British Pharmacopœia. The hydrocyanic acid is probably in chemical combination with the oil to the extent of about 5 per cent. According to Linde, the production of the benzaldehyde is preceded by the formation of benzaldehydcyanhydrin,  $\text{C}_6\text{H}_5\text{CH}(\text{OH})\cdot\text{CN}$ . The emulsin and amygdalin occur in different parts of the bitter almond.

*Test.*—The reaction between synaptase and amygdalin is applicable as a test of the presence of one by the addition of the other, even when mixed with much organic matter.

Jacobsen obtains true benzaldehyde artificially from benzodichloride (dichloromethylbenzene,  $\text{C}_6\text{H}_5\text{CHCl}_2$ ), one of the dichlorotoluenes, by heating with glacial acetic acid and chloride of zinc with a little water.

*Cherry-Laurel Water* (*Aqua Laurocerasi*, B. P., by distillation with water from *Laurocerasi Folia*, B. P.) contains hydrocyanic acid derived from a reaction similar to—indeed, probably identical with—that described above, for bitter almond oil is simultaneously produced. But the proportion of amygdalin or analogous body in cherry-laurel leaves is most variable; hence normally the strength of the water is highly uncertain. It may contain perhaps 2 to 4 parts of hydrocyanic acid in 10,000. The British Pharmacopœia, however, directs that it shall contain 0.1 per cent. of real hydrocyanic acid, it being strengthened by the addition of hydrocyanic acid, or if necessary, diluted by the addition of distilled water, until it has the prescribed strength.

*Prunus Virginiana*, U. S. P., the bark of *Prunus serotina* or *Cerasus serotina*, the Wild Black Cherry Bark, also furnishes by distillation an essential oil and hydrocyanic acid; quince-seeds also (*Cydonia vulgaris*). The Wild Black Cherry contains amygdalin.

*Caution.*—Essential oil of almonds is of course highly poisonous. The purified oil or benzaldehyde is almost innocuous; it is obtained on distilling the crude oil with milk of lime and ferrous chloride, and drying the product by shaking with fused chloride of calcium. The so-called “artificial oil of bitter almonds” or “nitrobenzol” [ $\text{C}_6\text{H}_5\text{NO}_2$ ], when taken in quantity, has been known to produce

death. The presence of nitrobenzol in oil of bitter almonds is detected by adding a little of the oil to a mixture of zinc and diluted sulphuric acid, shaking well, setting aside for an hour or two, filtering off the clear liquid, and adding a little chlorate of potassium; a violet color (actual mauve) is produced. The reaction is due to the formation of phenylamine or aniline (see p. 427). Or the specimen may be shaken with bisulphite of sodium (for all such aldehydes form a compound with bisulphite of sodium) to fix the essential oil, and then with ether, which dissolves out, and on evaporation will yield the nitrobenzol.

ARBUTIN ( $\text{C}_{25}\text{H}_{34}\text{O}_{14}$ ,  $\text{H}_2\text{O}$ ) is contained in the leaves of *Arctostaphylos uva ursi* and *Chimaphila umbellata* (*Chimaphila*, U. S. P., or *Pipsissewa*), and many ericaceous plants. It is a bitter neutral body occurring in acicular crystals, and resolvable by acids into hydrokinone ( $\text{C}_6\text{H}_6\text{O}_2$ ) and glucose, and by gentle oxidation into kinone ( $\text{C}_6\text{H}_4\text{O}_2$ ) and formic acid. *Ericolin* ( $\text{C}_{34}\text{H}_{56}\text{O}_{21}$ ) is another bitter glucoside in bearberry-leaves.

BRYONIN ( $\text{C}_{48}\text{H}_{80}\text{O}_{19}$ , Walz).—The colorless, bitter, indistinctly crystalline principle of Bryony (*Bryonia*, U. S. P., the root of *Bryonia alba* and *Bryonia dioica*).

CATHARTIC ACID.—“The glucoside acid that now is known to confer on the Senna of Alexandria (from *Cassia acutifolia*) and of India (from *Cassia elongata*) (*Senna*, U. S. P.) its purgative property has been named by its discoverers (Dragendorff and Kubly) cathartic acid. Its formula has been stated as  $\text{C}_{180}\text{H}_{192}\text{N}_4\text{SO}_{82}$ , which, if true, accounts for its extreme instability. It is insoluble in water, strong alcohol, and ether, but enters readily into either solution when combined with alkaline and earthy bases, in which state it exists in senna. Its ammonium salts give brownish flocculent precipitates with salts of silver, tin, mercury, copper, and lead. Antimonial salts, tannin, and yellow and red prussiates have no effect upon it. Alkalies, aided by heat, act destructively upon it. Boiled with a mineral acid, it splits into a peculiar kind of glucose and an acid that has been named cathartogenic; its formula is said to be  $\text{C}_{132}\text{H}_{116}\text{N}_4\text{SO}_{44}$ . The natural cathartate occurring in senna is prepared by partially precipitating by strong spirit a watery infusion of senna, concentrated to a syrupy state by evaporation *in vacuo*. The filtrate is now treated with a much larger bulk of absolute alcohol, and the precipitate thus obtained is purified by repeated solution in water and precipitation by alcohol. To obtain the pure acid, advantage is taken of its colloidal properties; the crude cathartate is dissolved in moderately strong hydrochloric acid, and subjected to dialysis on a diaphragm of parchment paper. The minimum dose of this pure acid was found to be about  $1\frac{1}{2}$  grains, which caused several stools with decided griping.

“The cathartic combinations that I have made are—the cathartate of ammonium, prepared from cathartate of lead by my original process, and the mixed cathartates, prepared according to Dragendorff’s method as modified by myself. Of the former nearly pure salt, I have found  $3\frac{3}{4}$  grains to purge fairly as to amount, but slowly as to time, and with considerable griping. Of the latter,  $7\frac{1}{2}$  grains purged



violently with much griping and sickness, which continued through the greater part of the day. It obviously would be improper to combine senna with any of its metallic precipitants, should such be desired, which is not likely. It is here satisfactory to observe that the cathartate of magnesium is soluble, and that the old-fashioned black draught agrees with new-fashioned science" (Groves).

*Buckthorn-juice* (*Rhamni Succus*, B. P.) owes its cathartic properties to a substance apparently identical with cathartic acid. Possibly the purgative properties of the bark of the *Rhamnus Frangula* (*Frangula*, U. S. P.), Black Alder, Buckthorn, also are due to cathartic acid.

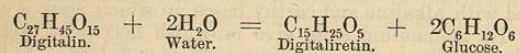
**COLOCYNTHIN** ( $C_{56}H_{84}O_{23}$ ?).—This substance is the active bitter and purgative principle of colocynth-fruit (*Colocynthis*, U. S. P.): it is soluble in water and alcohol, but not in ether. By ebullition with acids it furnishes glucose and a resinoid body.

**CONVOLVULIN**.—See JALAPIN.

**COTOIN** ( $C_{22}H_{18}O_6$ ) appears to be the chief active principle of Coto-bark, a Bolivian remedy for diarrhoea.

**DAPHNIN** ( $C_{31}H_{34}O_{19}$ ) is the crystalline glucoside of the bark of *Daphne mezereum* (*Mezeri Cortex*, B. P.). Boiled with dilute acids, it yields *daphnetin* ( $C_{19}H_{14}O_9$ ) and glucose. The acrid principle of mezereum is resinoid.

**DIGITALIN** ( $C_{27}H_{46}O_{15}$ , Kosmann;  $C_5H_8O_2$ , Schmiedeberg).—This is an active principle of the Foxglove (*Digitalis*, U. S. P.). On boiling a grain of digitalin with diluted sulphuric acid for some time, flocks of *digitaliretin* ( $C_{15}H_{25}O_9$ ) separate, and glucose may be detected in the liquid:—



**Properties**.—Digitalin occurs "in porous mammillated masses or small scales, white, inodorous, and intensely bitter, readily soluble in spirit, but almost insoluble in water and in pure ether; dissolves in acids, but does not form with them neutral compounds; its solution in hydrochloric acid is of a faint yellow color, but rapidly becomes green. It leaves no residue when burned with free access of air. It powerfully irritates the nostrils and is an active poison." According to Pettenkofer, "an intense red color is produced if a trace of digitalin dissolved in water is mixed with a weak aqueous solution of inspissated bile, and sufficient oil of vitriol added to raise the temperature to 158° F." Moistened with sulphuric acid and the liquid exposed to the vapor of bromine, a violet color is produced.

**Process**.—The process for the preparation of digitalin consists in dissolving the glucoside out of the digitalis-leaf by alcohol, recovering the alcohol by distillation, dissolving the residue in water by the help of a small quantity of acetic acid, removing much of the color from the solution by animal charcoal, neutralizing most of the acetic acid by ammonia, precipitating the digitalin by tannic acid (with which it forms an insoluble compound), washing the precipitate, rubbing and heating it with spirit and oxide of lead (which

removes the acid in the form of insoluble tannate of lead), again decolorizing by animal charcoal, evaporating to dryness, washing out impurities still remaining by ether, and drying the residual digitalin. In this form digitalin is uncrystallizable, and is somewhat indefinite.

**Pure Digitalin** (?).—On treating commercial digitalin with chloroform only an inert substance remains undissolved. The solution yields pure digitalin on evaporation; it may be crystallized from spirit in radiating needles (Nativelle). The therapeutic effect of the pure substance is identical with the preparations of digitalis, but, as might be expected, more constant in its action, and, of course, intensely powerful.

**Digitoxin** ( $C_{31}H_{33}O_7$ ) ( $C_{21}H_{32}O_7$ , Dragendorff) is a highly poisonous substance extracted from Foxglove by Schmiedeberg. The same chemist regards commercial digitalin from foxglove-seeds as composed of varying proportions of three glucosides—namely, pure active *digitalin* ( $C_5H_8O_2$ ), *digitonin* ( $C_{31}H_{52}O_{17}$ , closely allied to saponin), and *digitalein*, with inactive *digitalin* or *digitin*.

**ELATERIN** ( $C_{26}H_{28}O_8$ ).—Boil elaterium, the dried sediment from the juice of the squirting-cucumber fruit (*Ecballium*, *Elaterium*), in a small quantity of spirit of wine, and filter; fibrous and amylaceous matters remain insoluble, while elaterin and resin are dissolved. The filtrate, concentrated and poured into a warm solution of potash, yields, on cooling, crystals of elaterin, resin being retained by the alkali.\* It is purified by recrystallization from spirit (*Elaterin*, U. S. P.).

Elaterin is probably not a true glucoside. It does not always respond to the test for glucose after boiling with acids; and when it does the reaction is possibly due to *prophetin*, a glucoside stated by Walz to be present in elaterium.

Elaterin is the active principle of the so-called elaterium. Elaterium occurs "in light, friable, slightly-incurved cakes, about one line ( $\frac{1}{2}$  inch) thick, greenish-gray, acrid and bitter; fracture finely granular." Good specimens of this drug should yield not less than 20 per cent. of elaterin. Elaterium adulterated with chalk and other substances was formerly occasionally met with. A trituration of Elaterin is official (*Trituratio Elaterini*). It is a mixture of 1 part of elaterin with 9 of sugar of milk.

The best method of obtaining elaterin is to exhaust elaterium with chloroform, evaporate, and then to add ether to the residue, when crystalline elaterin remains. It should be washed with a little ether and crystallized from chloroform. When pure it occurs in hexagonal scales or prisms.

**Test**.—A little is placed in a watch-glass with a drop or two of liquefied carbolic acid, and then two or three drops of strong sulphuric acid: a carmine color is developed (Lindo).

**GENTIOPICRIN** or **GENTIAN BITTER** ( $C_{20}H_{30}O_{12}$ ), the neutral crystal-

\* "The alcoholic solution should not be precipitated by tannic acid nor by salts of mercury or of platinum (abs. of, and difference from, alkaloids)."



line principle of the root of *Gentiana lutea* (*Gentianæ Radix*, B. P.). It is soluble in water and weak spirit. Alkalies decompose it. Dilute acids convert it into *gentiogenin* and glucose. Gentian-root also contains a variety of tannin and a crystalline acid ( $\text{HC}_{14}\text{H}_9\text{O}_5$ ) termed *gentianic* or *gentisic acid*, or *gentisin*. Fused potash, etc. gives with the latter an acid ( $\text{C}_7\text{H}_6\text{O}_4$ ), which has also, unfortunately, been called gentisic acid.

GLYCYRRHIZIN ( $\text{C}_{24}\text{H}_{36}\text{O}_9$ , Gorup-Besanez) or *Glycyrrhizic Acid* ( $\text{C}_{44}\text{H}_{68}\text{NO}_{18}$ , Habermann).—Liquorice-root (*Glycyrrhiza*, U. S. P.), in addition to uncrystallizable sugar, contains 3 or 4 per cent. of a sweet substance, *glycyrrhizin*, which, when boiled with hydrochloric acid or diluted sulphuric acid, yields a resinoid bitter body, *glycyrretin*, and an uncrystallizable sugar resembling glucose. Glycyrrhizin is only slightly soluble in cold water, but is taken up by diluted alcohol containing a little ammonia (*Extractum Glycyrrhizæ Fluidum*, U. S. P.) or by ammoniacal water. An infusion of the latter, evaporated to a pilular consistence, forms *Extractum Glycyrrhizæ Purum*, U. S. P. It is present in considerable quantity in the evaporated decoction (*Stick Liquorice*, *Spanish Liquorice*, or *Solazzi Juice*). The tropical substitute for liquorice is the root of *Abrus precatorius* or *Indian Liquorice* (*Abri Radix*, P. I.), the *kunch* or *gunj* of Bengal, the *ratti* of Hindustan, and the *jequirity* of Brazil, which also apparently contains glucose and glycyrrhizin. (The seeds yield by maceration a substance which acts as a poison when injected into the blood, but not when swallowed. Warden and Waddell regard the active principle as an albuminoid and term it *abrin*. Bruylants and Venneman consider it to be a product of germination and call it *jequeritin*. Béchamp and Dujardin regard the latter as a mixture of legumin and *jequirityzymose*.) Glycyrrhizin has considerable power of disguising nauseous flavors. Rousin refers the sweet taste of liquorice not to pure glycyrrhizin, but to a combination of glycyrrhizin with alkalies, and states that ammoniacal glycyrrhizin has exactly the sweetness of liquorice-root. The formula of this *glycyrrhizate of ammonium* is said by Habermann to be  $(\text{NH}_4)_3\text{C}_{44}\text{H}_{68}\text{NO}_{18}$ . Sestini finds that the glycyrrhizin of liquorice-root is chiefly glycyrrhizate of calcium.

An ammoniated glycyrrhizin (*Glycyrrhizinum Ammoniatum*, U. S. P.) is directed to be prepared by precipitating a dilute ammoniacal percolate with sulphuric acid, washing, redissolving in ammoniacal water, reprecipitating, again washing, dissolving in solution of ammonia, and spreading on glass plates to dry until reddish-brown scales are obtained.

GUAIACIN.—Resin of Guaiacum (*Guaiaci Resina*, U. S. P.), an exudation from the wood (*Guaiaci Lignum*, U. S. P.) of *Guaiacum officinale*, is probably a mixture of several substances, among which are *Guaiaretic* or *Guaiaretinic acid* ( $\text{C}_{20}\text{H}_{26}\text{O}_4$ , Hlasiwetz), *Guaiaconic acid* ( $\text{C}_{38}\text{H}_{40}\text{O}_{10}$ , Hadelich), and *Guaiacin*, a glucoside. On boiling guaiacum resin with diluted sulphuric acid for some time, glucose is found in the liquid, a green resinous substance (*guaiaretin*) remaining insoluble (Kosmann). Most oxidizing agents, and even atmospheric air, especially under the influence of certain

organic substances, produce a blue, then green, and finally a brown color when brought into contact with an alcoholic solution of guaiacum resin.

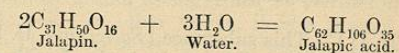
These effects are said to be due to three stages of oxidation (Jonas). They may be observed on adding the solution to the inner surface of a paring of a raw potato.

HELLEBORIN ( $\text{C}_{36}\text{H}_{42}\text{O}_6$ ) and HELLEBOREIN ( $\text{C}_{26}\text{H}_{44}\text{O}_{15}$ ) are crystalline glucosides occurring in the roots of Black Hellebore (*Helleborus niger*) or Christmas Rose, and Green Hellebore (*H. viridis*), ranunculaceous herbs.

JALAPIN ( $\text{C}_{31}\text{H}_{50}\text{O}_{16}$ ) and CONVULVULIN ( $\text{C}_{34}\text{H}_{56}\text{O}_{16}$ ).—According to Keyser and Meyer, jalap resin contains two distinct substances—convulvin, chiefly obtained from Mexican male jalap (*Ipomœa orizabensis*), and jalapin, most largely contained in the true jalap (*Ipomœa purga*); the former is soluble in ether, the latter insoluble. Boil jalap resin with diluted sulphuric acid for some time, and filter; a substance, which is probably a mixture of *jalapinol* ( $\text{C}_{13}\text{H}_{24}\text{O}_3$ ) and *convulvulinol* ( $\text{C}_{16}\text{H}_{30}\text{O}_3$ ), separates, and glucose may be detected in the clear liquid. (It is to be regretted that the authors transpose the above names, terming the old well-known jalapin convulvin.)



*Jalapic Acid*.—This is contained in the portion of jalap resin soluble in ether. It may also be obtained from jalapin by ebullition with alkalies:—



*Jalap Resin* (*Resina Jalapæ*, U. S. P.) is obtained by digesting and percolating jalap-tubercles (*Jalapa*, U. S. P.), with spirit of wine, adding a little water, distilling off the spirit, pouring away the aqueous portion, which contains much saccharine matter, and washing and drying the residual resin. Jalap, thoroughly exhausted by this process, should furnish, according to the United States Pharmacopœia, not less than 12 per cent. of resin, of which resin (*Resina Jalapæ*, U. S. P.) not more than one-tenth should be soluble in ether—a test which excludes the so-called “Tampico” jalap, the resin of which is soluble in ether. The tincture of jalap is sometimes decolorized by animal charcoal, and the evaporated product sold as “jalapin.”

Jalap resin is insoluble in oil of turpentine; common resin, or rosin, soluble. If the presence of the latter is suspected, the specimen should be powdered, digested in turpentine, the mixture filtered, and the filtrate evaporated; no residue, or not more than yielded by the turpentine itself, should be obtained.

*Tampico Jalap*, from *Ipomœa simulans*, yields a resin which appar-



ently is chiefly convolvulin, but sometimes contains jalapin; for a sample obtained by Hanbury was entirely soluble in ether, and another extracted by Umney was almost wholly soluble, while Evans purified some, half only of which was soluble.

The *Kaladana resin*, or *Pharbitisin* of India (from *Pharbitis Nil*, P. I.), is a cathartic analogous to, if not identical with, resin of jalap.

*Loganin*,  $C_{25}H_{34}O_{14}$ , is a glucoside obtained from the pulp of the fruit and from the seeds of *Strychnos nux-vomica*, Loganiaceæ, by Dunstan and Short. Boiled with dilute sulphuric acid, it yields glucose and *loganetin*.

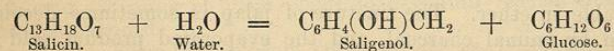
**PICROTOXIN**, U. S. P., is a crystalline bitter poisonous principle ( $\pi\kappa\rho\delta\varsigma$ , *picros*, bitter, and  $\tau\omicron\varsigma\iota\kappa\omicron\nu$ , *toxicon*, poison) occurring in *Cocculus indicus*, the dried fruits of *Anamirta cocculus* (*Anamirta Caniculata*, Colebrooke). Ludwig regarded it as a glucoside, but its constitution is not yet satisfactorily ascertained. Barth and Kretschy state that the so-called picrotoxin may be separated into *picrotoxin* proper ( $C_{15}H_{16}O_6$ ,  $H_2O$ ), which is bitter and poisonous; *pirotin* ( $C_{25}H_{30}O_{12} + nH_2O$ ), which is bitter, but not poisonous; and *anamirtin* ( $C_{19}H_{24}O_{10}$ ), which is neither bitter nor poisonous. Schmidt asserts that the original picrotoxin is definite, and has the formula  $C_{30}H_{34}O_{13}$ , but that some solvents decompose it into *picrotoxinin*,  $C_{15}H_{16}O_6$ , which is poisonous, and *pirotin*,  $C_{15}H_{18}O_7$ , which is not poisonous.

**QUASSIN** ( $C_{10}H_{12}O_8$ , Wiggers, or  $C_{31}H_{42}O_9$ , Christensen), obtained from *Quassia Lignum*, is said to be a glucoside, but Oliveri and Denaro question the statement, and find quassia to have the formula  $C_{32}H_{44}O_{10}$ .

**SALICIN** ( $C_{13}H_{18}O_7$ ).—This substance (*Salicinum*, U. S. P.) is contained in, and easily extracted from, the bark of willow, *Salix Alba* (*Salix*, U. S. P.), and of other species of *Salix*, especially from *Salix helix*. It occurs in white, shining, bitter crystals, soluble in about twenty-eight times its weight of water or sixty-five of spirit at common temperatures.

**Tests.**—1. To a small portion of salicin placed on a white plate or dish add a drop of strong sulphuric acid; a deep-red color is produced.

2. Boil salicin with diluted sulphuric acid for some time; it is converted into *saligenin* or *saligenol* ( $C_7H_8O_2$ ) and glucose.

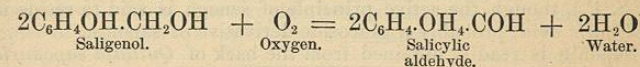


Examine a portion of the solution for grape-sugar by the copper test.

3. To another portion of the liquid, carefully neutralized, add a persalt of iron: a purplish-blue color is sometimes produced, due to the reaction of the saligenin and the ferric salt. The saligenin is, however, so rapidly decomposed by acids into *saliretin* ( $C_7H_6O$ ) and water that this reaction is almost valueless

as a test. Saligenin may readily be obtained by action of synaptase on salicin.

4. Heat a mixture of about 1 part of salicin, 1 of red chromate of potassium,  $1\frac{1}{2}$  of sulphuric acid, and 20 of water in a test-tube; a fragrant characteristic odor is evolved, due to the formation of salicylic aldehyde ( $C_6H_4OH.CO_2H$ ), an essential oil identical with that existing in meadow-sweet (*Spiræa ulmaria*) and in heliotrope.



**SANTONIN** ( $C_{15}H_{18}O_3$ ).—This substance is, apparently, the anhydride of a weak acid (Hesse) insoluble in ammonia, but forming a soluble calcium salt. Indeed, by boiling santonin for twelve hours with baryta-water, Cannizzarro has obtained a salt from which hydrochloric acid separates *santoninic acid* ( $C_{15}H_{20}O_4$ ). *Santoninate of Sodium* (*Sodii Santoninæ*, U. S. P.) has the formula  $2NaC_{15}H_{18}O_3 \cdot 7H_2O$ , and occurs in colorless crystals unstable when exposed to light. From a solution of santonate of calcium the santonin is precipitated by acids. Boiled for some time with diluted sulphuric acid, it yields 87 per cent. of an insoluble resinous substance (*santoniretin*) and glucose (Kosmann). *Santonin* (*Santoninum*, U. S. P., and *Trochischi Sodii Santoninatis*, U. S. P.) is official. It is soluble in an aqueous solution of twice its weight of carbonate of sodium. Possibly, in constitution, as suggested by Berthelot, santonin resembles carbolic acid; in other words, it is a phenol,  $C_{15}H_{15}O_3H$ .

**Process.**—The process for its preparation consists in boiling *Santonica*, U. S. P. (the unexpanded flower-heads of *Artemisia Maritima*, U. S. P., or *Levant worm-seed*), with milk of lime (whereby santonate of calcium is formed), straining, precipitating the santonin or santoninic acid by hydrochloric acid, washing with ammonia to remove resin, dissolving in spirit and digesting with animal charcoal to get rid of coloring-matter, setting the spirituous solution aside to deposit crystals of santonin, and purifying by recrystallization from spirit (Mialhe).

**Test.**—To highly diluted solution of perchloride of iron add an equal bulk of concentrated sulphuric acid. To this reagent add the santonin, or powder or substance suspected to be santonin, and cautiously apply heat. A red, purple, and finally violet color is produced (Lindo). *Santonin* added to warm alcoholic solution of potash yields a violet-red color.

*Tanacetie Acid*, from the leaves and tops of *Tanacetum vulgare*, or *Tansy* (*Tanacetum*, U. S. P.), is a yellow crystalline acid having the medicinal properties of santonin.

**SAPONIN** ( $C_{30}H_{48}O_{18}$ , Rochleder, Schiaparelli also) is a peculiar glucoside occurring in Soapwort, the root of the common Pink, and many other plants: its solution in water, even though very dilute,



froths like a solution of soap. Heated with dilute acids, it yields sugar and *saponetin*,  $C_{40}H_{66}O_{15}$ . Pereira considered *smilacin* (*Sal-separin* or *Parallin*) one of the principles of the supposed activity of the root of *Smilax officinalis*, or Sarsaparilla (*Sarsaparilla*, U. S. P.), to be closely allied to, if not identical with, saponin. According to Klunge (*Pharmacographia*), *parallin*, by action of acids, yields *parigenin*. The aqueous solutions of *parallin* froth when shaken.

Saponin is also met with in the root of *Polygala Senega* (*Senega*, U. S. P.), though the active principle of *senega* is said to reside in *polygalic acid*, probably a glucoside-derivative of saponin.

Saponin is readily obtained from the bark of *Quillaia saponaria* or *soap-bark* (*Quillaia*, U. S. P.) by boiling the aqueous extract in alcohol and filtering while hot. Flocks of saponin separate on cooling. It is a white, non-crystalline, friable powder. The alleged toxic properties of commercial saponin are said by Kobert to be due to *sapotoxin* and *quillaic acid*.

SCAMMONIN ( $C_{34}H_{56}O_{16}$ ).—Boil resin of scammony (*Resina Scammonii*, U. S. P.) with diluted sulphuric acid for some time; glucose may then be detected in the liquid, a resinous acid termed *scammonioid* ( $C_{14}H_{13}O_3$ ?) being produced at the same time.

Natural scammony (*Scammonium*, U. S. P.) is an exudation from incisions in the living root of *Convolvulus Scammonia*. It contains from 10 to 20 per cent. of gum, and therefore when rubbed up with water gives an emulsion. "Ether removes about 75 per cent. of resin" (B. P.). The official resin of scammony contains no gum, and therefore gives no emulsion when rubbed up with water. It is made by digesting the root in spirit, adding water, distilling off the alcohol, and washing the residual resin with hot water till free from gum. There seems to be little or no chemical difference between the extracted resin and the resin of the exuded scammony.

Resin of scammony is soluble in all proportions in ether. Spargatis states that it is identical with the resin of Mexican Male Jalap, which also is soluble in ether. Sulphuric acid slowly reddens it. It is said to be liable to adulteration with resin of true jalap, guaiacum resin, and common rosin. Resin of true jalap is insoluble in ether; guaiacum resin is distinguished by the color-tests mentioned under GUALACIN, and rosin by the action of sulphuric acid.

SCILLITIN.—Schroff, and afterward Riche and Remont, believed the bitter principle of the squill-bulb (*Scilla*, B. P.) to be a glucoside. Merck has extracted substances which he has termed *scillipicrin*, *scillitoxin*, and *scillin*. Schmiedeberg has given the name of *sinestrin* to a squill principle. But no definite crystalline principle has yet been obtained. Squill contains a large quantity of mucilage.

The bulbous root of *Crinum asiaticum* is official in the Pharmacopoeia of India (*Crini Radix*, P. I.) as a substitute for squill. It has not been chemically investigated.

STROPHANTHIN ( $C_{20}H_{34}O_{10}$ ).—According to Frazer, this is the active principle of strophanthus-seed (*Strophanthus Kombé*), and is a glucoside. He obtained it in crystals. Acids convert it into glucose and crystalline *strophanthidin*. Phosphomolybdic acid produces in solutions of strophanthin a bright bluish-green color. Helbing states that its aqueous solution yields, with a trace of solution of perchloride of iron and a little sulphuric acid, a reddish-brown precipitate which after an hour or two turns green. Sulphuric acid colors strophanthin dark green, changing to reddish brown. Recent researches indicate that strophanthin is only one of the active principles of the different varieties of strophanthus.

#### QUESTIONS AND EXERCISES.

803. Define glucosides, and mention those of pharmaceutical interest.
804. Draw out an equation illustrative of the development of oil of bitter almonds.
805. How much pure amygdalin will yield one grain of real hydrocyanic acid?
806. To what does cherry-laurel water owe activity?
807. Mention the active principle of senna.
808. By what process is the glucoside of the purple foxglove prepared?
809. State the circumstances under which guaiacum resin and jalap resin yield glucose.
810. Mention a test for guaiacum resin.
811. How may the adulteration of jalap resin by rosin be detected?
812. Enumerate the tests for salicin.
813. How is santonin officially prepared?
814. Name sources of saponin.
815. What is the difference between scammony and resin of scammony?
816. How would you detect resins of turpentine, guaiacum, or jalap in resin of scammony?

#### BITTER OR TONIC SUBSTANCES, ETC.

The following articles, employed medicinally in such forms as decoction, extract, infusion, tincture, etc., contain active principles which have not yet been thoroughly examined. Some of these principles have been isolated, and a few have been obtained in the crystalline condition; but their constitution has not been sufficiently well made out to admit of the classification of the bodies either among alkaloids, glucosides, acids, or other well-marked principles:—

<i>Andrographis Caules et Radix</i> , P. I., from <i>Andrographis pa- niculata</i> Kariyat.	<i>Apocynum</i> . Canadian hemp. <i>Asclepias tuberosa</i> . Pleurisy-root (Asclepedin).
<i>Anthemidis flores</i> .	<i>Aurantii cortex</i> (Hesperidin).



- Azadirachta Cortex et Folia*, P. I., from *Azadirachta indica*, Nim or Margosa. (A resin;  $C_{36}H_{50}O_{11}$ . Broughton.)  
*Bonducella semina*, P. I., from *Cesalpinia (guilandina) bonducella*. Bonduc-seeds or nick-ar-nuts.  
*Buchu folia*.  
*Calendula officinalis*. Marigold. (Calendulin, Stoltze.)  
*Calotropis Cortex*, P. I., from *Calotropis procera* and *C. gigantea*. Mudar.  
*Canella cortex* (Cascarillin,  $C_{12}H_{14}O_4$ ).  
*Caulophyllum thalictroides*. Blue cohosh. Alkaloid?  
*Cimicifuga (Actæa) racemosa* (Cimicifugin; said by Conard to be neutral, and by Falck alkaloidal). Black snake-root (*Cimicifuga Rhizoma*, B. P.).  
*Cypripedium pubescens* (Cypripedin?). Ladies' Slipper.  
*Euonymus atropurpureus*. Wahoo-bark (Euonymin?).  
*Eupatorium perfoliatum*. Thoroughwort or Boneset.  
*Gulancha (Tinospora) Radix et Caules*, P. I.).  
*Gynocardia semina*, from *Gynocardia odorata (Chaulmugra)*, P. I.).  
*Hamamelis virginica*. Witch-hazel.  
*Hydrocotyles folia*, P. I., from *Hydrocotyle asiatica*. Indian pennywort.  
*Iris versicolor*. Blue flag (Iridin or Irisin?).  
*Lactuca* (Lactucin, etc.). The milk-juice, dried, yields *Lactucarium*, U. S. P.  
*Lappa*, U. S. P., *Arctium lappa*, *Lappa officinalis*. Burdock.  
*Lupulus*.  
*Magnolia*. Swamp Sassafras or Beaver Tree.  
*Marrubium*. Horehound. Marrubein, a crystalline bitter substance (Mein).  
*Matica folia*. Matico.  
*Melia Azedarach* (Resin, Jacobs).  
*Pepo*. The seed of *Cucurbita pepo*. A remedy for tape-worm.  
*Phytolacca Bacca et Radix*. Pokeberry and root. Phytolaccin, a crystalline substance (Claassen).  
*Scutellaria*. Skullcap.  
*Serpentaria*. Virginia Snakeroot.  
*Soymida Cortex*, P. I. Rohunbark, from *Soymida febrifuga*.  
*Taraxaci radix* (Taraxacin).  
*Toddalia radix*, P. I.  
*Triticum repens*. Rhizome of couch-grass.  
*Veronica virginica*, or *Leptandra virginica*. Culvers-root; *Leptandra*, U. S. P. (Leptandrin?).  
*Viburnum*. Black haw (*Viburnin*).

## ALKALOIDS.

## Constitution of Alkaloids or Organic Bases.

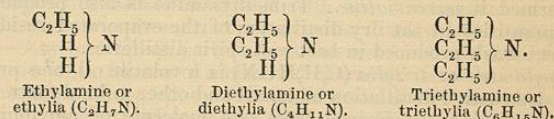
*Natural Alkaloids*.—The natural organic bases, alkaloids, or alkali-like bodies (*είδος*, *eidos*, likeness), have many analogies with ammonia. Their constitution, as a class, is not yet satisfactorily known; but some are probably direct derivatives of a single molecule of ammonia ( $NH_3$ ) or of double, triple, or quadruple molecules ( $N_2H_6$ ,  $N_3H_9$ ,  $N_4H_{12}$ ); others of ammonias in which the ammoniacal structure is largely merged in or conditioned by a benzenoid or aromatic structure, or, *vice versa*, in which the ben-

zenoid character is conditioned by the ammoniacal; while others, again, certainly appear to be benzenoid, but of a more or less nitrogen-benzene (pyridinoid) rather than a completely carbon-benzene character—benzene (p. 634) in which  $CH'''$  is displaced by  $N'''$ .

*Artificial Alkaloids*.—Numerous artificial alkaloids or artificial organic bases having a simple ammoniacal constitution have already been formed. These are sometimes termed amines, and are primary, secondary, and tertiary according as one, two, or three atoms of hydrogen in ammonia have been displaced by radicals, as seen in the following general formulæ ( $R$  = any univalent radical):—



or in the following examples:—



The three classes have also been termed amidogen-bases ( $NH_2$ ), imidogen-bases ( $NH$ ), and nitrile-bases ( $N$ ).

*Mode of Formation of Artificial Ammoniacal Alkaloids*.—A few illustrations will suffice. Just as the addition of iodide of hydrogen ( $HI$ ) to ammonia (that is, the common trihydrogen ammonia,  $NH_3$ ) gives iodide of common ammonium ( $NH_4HI$  or  $NH_4I$ ), so the addition of iodide of ethyl ( $C_2H_5I$  or  $EtI$ ) (see page 401) to ammonia ( $NH_3$ ) gives the iodide of ethyl-ammonium ( $NH_3H_2EtI$ , or  $NH_3EtI$ , or  $NH_3C_2H_5I$ ). A fixed alkali turns out common ammonia ( $NH_3$ ) from the iodide (or any other salt) of common ammonium; it turns out ethyl-ammonia ( $NH_3H_2Et$ ) from the iodide (or any other salt) of ethyl-ammonium. Ethyl-ammonia (or *ethylia* or ethylamine),  $NH_3H_2Et$ , with iodide of ethyl,  $EtI$ , gives iodide of diethyl-ammonium [ $NH_3H_2EtEtI$ , or  $NH_3Et_2I$ , or  $NH_3(C_2H_5)_2I$ ]. From the latter, potash turns out diethyl-ammonia ( $NH_3Et_2$ ). Diethyl-ammonia (*diethylia* or diethylamine) with iodide of ethyl gives iodide of triethyl-ammonium ( $NH_3Et_3I$ ). The latter with alkali gives triethyl-ammonia or *triethylia* or triethylamine ( $NEt_3$ ), and this with iodide of ethyl gives iodide of tetrethyl-ammonium,  $NEt_4I$ .

What has just been stated respecting iodide of ethyl is true of other salts of ethyl; and what is true of salts of ethyl is true of salts of an immense number of other radicals—univalent, bivalent, etc.; so that a vast number of artificial ammoniacal alkaloids and their salts can be produced. The reactions are not always so sharp as those just given. Mixtures of primary, secondary, and tertiary compounds rather than either alone often result in an experiment: but the reactions are typically true.

Some of these artificial ammoniacal alkaloids not only resemble