

Caprylic acid, $\text{CH}_3(\text{CH}_2)_6\text{COOH}$, and Capric acid, $\text{CH}_3(\text{CH}_2)_8\text{COOH}$, are found in sweat, in cheese, and as glycerides in butter. Caprylic melts at 16.5°C . and volatilizes at 236°C . Capric melts at 30°C . and volatilizes at 270°C .

Lauric acid, $\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$, and Myristic acid, $\text{CH}_3(\text{CH}_2)_{12}\text{COOH}$, are present as glycerides in human fat and in butter, also as compound ethers in spermaceti. Lauric acid melts at 43.6° and myristic at 53.8°C .

Palmitic acid, $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$, is found as a glyceride in all animal fats and as compound ethers in spermaceti and beeswax; it is also found combined with cholesterol in wool fat (lanolin). It melts at 62°C .

Stearic acid, $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$, is found combined like palmitic acid in animal fats and spermaceti. It melts at 69.2°C . Margarinic acid is a name sometimes applied to a mixture of palmitic and stearic acids.

Arachidic acid, $\text{CH}_3(\text{CH}_2)_{18}\text{COOH}$, is found in butter as a glyceride. It melts at 75°C .

Cerotic acid, $\text{CH}_3(\text{CH}_2)_{20}\text{COOH}$, is found free in beeswax. Combined as cetyl ether, it forms the principal part of Chinese wax. The free acid forms granular crystals, which melt at 78°C .

Acrylic Acid Series, $\text{C}_3\text{H}_5\text{O}_2$.—Some of the higher members of this series form compounds with glycerin, resembling the neutral fats. The most important member of this group physiologically is—

Oleic acid, $\text{CH}_3(\text{CH}_2)_{14}(\text{CH})\text{COOH}$; it is found united with glycerin in all the fats of the body, as a liquid fat, olein, which holds the higher fats of the fatty acid series in solution at the body temperature.

Glycolic Acid Series, $\text{C}_2\text{H}_3\text{O}_3$.—Carbonic acid, $\text{OH}\cdot\text{COOH}$, is unknown in its free state, being doubtless too unstable to exist. Its salts, however, are present in large quantities in the body, and play an important part in the alkalinity of the tissues and fluids. Its corresponding oxide, CO_2 , is the principal form in which carbon leaves the body.

Glycolic acid, $\text{H}\cdot\text{CHOH}\cdot\text{COOH}$, does not occur in the body.

Lactic acid, $\text{CH}_3\cdot\text{CHOH}\cdot\text{COOH}$, exists in three isomeric varieties:

1. Fermentation lactic acid is present in sour milk, and in the stomach and intestines during digestion. It is also found in small quantities in the muscles and brain, and in diabetic urine. It is a colorless or faintly yellow liquid of syrupy consistency, and is distinguished from the two following by being optically inactive.

2. Paralactic or sarcocollactic acid is the principal acid of meat extracts and of muscle, and is also found in numerous glands. It is present in the sweat in puerperal fever, and in the urine after severe fatigue, in acute yellow atrophy of the liver, and in phosphorus poisoning. It is dextro-rotatory to polarized light.

3. A third laevo-rotatory lactic acid has been obtained by the fermentation of cane sugar by a special bacillus.

Oxybutyric acid, $\text{CH}_3\cdot\text{CH}_2\cdot\text{CHOH}\cdot\text{COOH}$, found along with diacetic acid and acetone in the blood and urine of diabetes, is an odorless syrupy liquid, which mixes freely with water, alcohol, and ether, and rotates polarized light to the left.

Oxalic Acid Series, $\text{C}_2\text{H}_2\text{O}_4$.—Oxalic acid, $\text{COOH}\cdot\text{COOH}$, is found in small quantities in the urine as calcium oxalate, and often occurs in excess after the ingestion of rhubarb or cabbage. It is usually increased where the amount of uric acid is increased. It may be obtained in the laboratory along with urea and carbonic acid gas from the oxidation of uric acid, and it is believed to be formed from the latter in the body to some extent. Oxalic acid is a violent poison. It crystallizes from aqueous solutions in large, transparent prisms, which effloresce when exposed to the air.

Succinic acid, $\text{COOH}\cdot(\text{CH}_2)_2\cdot\text{COOH}$, has occasionally been found in the urine after the ingestion of asparagus and other vegetables and fruits. It has also been detected in the sweat, the intestinal contents, and in the thymus and thyroid glands. It forms large colorless

crystals which are unaltered by the air and which fuse at 180°C .

Amido Acids are derived from the fatty acids by replacing one or more hydrogen atoms by amidogen, NH_2 . They are formed from proteids and albuminoids (gelatin) during digestion and metabolism, and are considered important precursors of urea.

Carbamic acid, $\text{OH}\cdot\text{CO}\cdot\text{NH}_2$, amidoformic acid, is not known in the free state. Its ammonium salt has been found in the blood and is believed to be an intermediate substance between proteids and urea.

Leucin, $(\text{CH}_2)_2\cdot\text{CH}\cdot\text{CH}_2\cdot\text{CH}\cdot\text{NH}_2\cdot\text{COOH}$, α -amidoisobutylic acid, is isomeric with and was formerly considered identical with amidopropionic acid. It is present wherever proteids are being broken up by tryptic digestion, by boiling with dilute acids or by putrefaction. It has been found in certain glands after death, and is found in the urine in acute yellow atrophy of the liver and phosphorus poisoning. There are satisfactory proofs of its being one of the precursors of urea. It crystallizes if pure in shining white plates, but usually forms characteristic round knobs or balls.

Tyrosin, $\text{HO}\cdot\text{C}_6\text{H}_4\cdot\text{C}_2\text{H}_5\cdot\text{NH}_2\cdot\text{COOH}$, p -oxyphenyl-amidopropionic acid, contains a phenyl group, and is consequently a member of the aromatic group of substances as well as an amido acid. It is formed with leucin from the breaking up of proteids in pancreatic digestion, and especially in putrefaction. It crystallizes in colorless, silky, fine needles, which are often grouped into tufts or balls. It has not been definitely proved to be a precursor of urea.

Aspartic acid, $\text{HOOC}\cdot\text{C}_2\text{H}_4\cdot\text{NH}_2\cdot\text{COOH}$, amidosuccinic acid. It is formed from proteids during pancreatic digestion, and is probably a precursor of urea in the animal body. It crystallizes in rhombic prisms.

Glutamic acid, $\text{HOOC}\cdot\text{C}_3\text{H}_5\cdot\text{NH}_2\cdot\text{COOH}$, amidopyrotartaric acid. It is formed along with aspartic acid during pancreatic digestion. It crystallizes in rhombic tetrahedra or octahedra or in small leaves.

Lysin, $\text{C}_6\text{H}_{14}\cdot\text{N}_2\cdot\text{O}_2$, Arginin, $\text{C}_6\text{H}_{14}\cdot\text{N}_3\cdot\text{O}_2$, and Histidin, $\text{C}_6\text{H}_9\cdot\text{N}_3\cdot\text{O}_2$, are probably amido acids, but in their reactions they resemble bases and are grouped together under the name of the hexone bases because they each contain six atoms of carbon. They are among the products of proteid decomposition. Lysatin or lysatinin, which is sometimes given as a separate substance, is probably a mixture of lysin and arginin.

Glycocoll, $\text{NH}_2\cdot\text{CH}_2\cdot\text{COOH}$, amidoacetic acid, is also known as glycocin or glycine. It is formed from the decomposition of proteids and albuminoids, and is found free in the intestine as a result of the breaking up of the bile salts. It is also set free when hippuric acid is boiled with mineral acids or alkalis.

Sarcosin, $\text{NH}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{COOH}$, methyl glycocoll, is not found in the body.

Creatin, $\text{NH}\cdot\text{CNH}_2\cdot\text{NCH}_2\cdot\text{CH}_2\cdot\text{COOH}+\text{H}_2\text{O}$, may be prepared synthetically from cyanamide, $\text{CN}\cdot\text{NH}_2$, and sarcosin. It occurs among the extractives of muscle and is regarded as a probable precursor of urea. When injected into the blood, however, it loses the elements of water and appears in the urine as creatinin, $\text{C}_4\text{H}_7\cdot\text{N}_3\cdot\text{O}$.

Taurin, $\text{NH}_2\cdot\text{C}_2\text{H}_4\cdot\text{SO}_2\cdot\text{OH}$, amidosethionic acid, is found combined in the bile salts. It may occur free in small quantities in the intestines. It crystallizes in colorless, shining, four to six sided prisms, often of large size.

Bile Acids.—Glycocholic and taurocholic acids are found in the bile combined with soda to form the bile salts. They consist of cholalic acid in combination with glycocoll and taurin respectively.

Glycocholic acid, $\text{C}_{26}\text{H}_{45}\text{NO}_7$, is found in human and ox bile, but is absent or nearly so from that of carnivora. Taurocholic acid, $\text{C}_{26}\text{H}_{45}\text{NSO}_7$, is found principally in the bile of the carnivora and man, but is also present in oxen, sheep, and goats.

Cholalic acid, $\text{C}_{24}\text{H}_{41}\text{O}_7$, is found combined in the above-named bile acids. It is insoluble in water, but soluble in alcohol, and slightly so in ether. It crystallizes in rhombic prisms or in large rhombic tetrahedra or

octahedra. Choleic acid, $\text{C}_{24}\text{H}_{40}\text{O}_7$, and fellic acid, $\text{C}_{22}\text{H}_{36}\text{O}_7$, are also present in small quantities in human bile, combined in place of cholalic acid in the bile salts.

Aromatic Acids.—Acids of the benzene series. A number of these are present in the body in small quantities. They are derived partly from the aromatic substances contained in the food, and partly from the breaking up of proteids. Tyrosin has been already described under the amido acids. The following are found principally in the urine:

Hippuric acid, $\text{C}_6\text{H}_5\cdot\text{CO}\cdot\text{NH}\cdot\text{CH}_2\cdot\text{COOH}$. Benzoyl-amidoacetic acid occurs in large quantities in the urine of herbivora, but only in small quantities in the carnivora and man. The quantity in the urine is increased by vegetable food containing benzoic acid compounds, and by putrefactive processes in the intestine. It may be decomposed into benzoic acid and glycocoll.

Ethereal sulphuric acids include the following four acids. phenol-sulphuric acid, $\text{C}_6\text{H}_5\cdot\text{O}\cdot\text{SO}_2\cdot\text{OH}$, cresol-sulphuric acid, $\text{C}_7\text{H}_7\cdot\text{O}\cdot\text{SO}_2\cdot\text{OH}$, indoxyl-sulphuric acid or indican, $\text{C}_8\text{H}_7\text{N}\cdot\text{O}\cdot\text{SO}_2\cdot\text{OH}$, and skatoxyl-sulphuric acid, $\text{C}_8\text{H}_5\text{N}\cdot\text{O}\cdot\text{SO}_2\cdot\text{OH}$.

These acids are all found in the urine, and are derived from the phenol, cresol, indol, and skatol which are formed in the intestines as a result of the putrefaction of proteids. Any circumstances favoring the latter process, such as intestinal diseases accompanied by obstruction, increase the amount of these acids in the urine.

Aromatic oxyacids, of which the principal are paroxy-phenyl-acetic acid, $\text{C}_6\text{H}_4\cdot\text{OH}\cdot\text{CH}_2\cdot\text{COOH}$, and paroxy-phenyl-propionic acid, $\text{C}_6\text{H}_4\cdot\text{OH}\cdot\text{C}_2\text{H}_4\cdot\text{COOH}$, are formed from tyrosin in small quantities in the intestine and pass unchanged into the urine.

Nucleic Acids.—These are acids rich in phosphorus, of complex and variable composition, found among the most characteristic constituents of cell nuclei. They combine with proteids to form numerous varieties of nuclein and nucleoproteid. Among the products of their decomposition, the most important are the alloxuric bodies, also known as the xanthin or still better as the purin bodies.

Uric Acid.— $\text{C}_5\text{H}_4\text{N}_4\text{O}_3$, trioxypurin, is found in adult human urine to the extent of from seven to ten grains per day, combined with bases to form urates. In birds and reptiles it replaces urea in the urine as the principal end product of proteid metabolism. In man it is derived principally from the nuclei of broken-down cells and from the purin bodies contained in the food. The extent to which it is formed from proteids in the body cannot be considered settled. For further details about uric acid, see the articles on *Gout* and *Urine*.

Wesley Mills.
William S. Morrow.

ACIDS, MINERAL, TOXICOLOGY OF.—The only mineral acids which require extended consideration at the hands of the toxicologist or physician are sulphuric, nitric, and hydrochloric acids.

I. Sulphuric Acid.—A number of different forms of sulphuric acid occur in commerce.

First, the pure acid, colorless and oily, known as *chemically pure sulphuric acid*, having a specific gravity of 1.842, and containing about 99 per cent. of sulphuric acid.

Second, a solution of much the same appearance containing 92.5 per cent. of sulphuric acid, the *Acidum sulphuricum* of the United States Pharmacopœia.

Third, the dilute, watery solution of the acid, also clear and colorless, containing 10 per cent. of sulphuric acid, the *Acidum sulphuricum dilutum* of the United States Pharmacopœia.

Fourth, the *commercial acid* of varying strength, and colored brown to black by organic impurities.

The concentrated acid in all its forms is intensely corrosive, destroying readily any organic tissue with which it may come in contact. Its power in this direction is due to its avidity of water, it being able to extract the elements of water from wood, cloth, or flesh, leaving the residue charred and more or less blackened as a result.

On clothing, if dark colored, the acid produces a brown stain with red edges, and after a time decomposes and softens the fibres of the cloth, so that it easily falls to pieces. The acid spot is always wet, due to absorption of water from the material and from the air. On light-colored cloth the acid produces a brown stain, which after a time turns black and destroys the tissue of the cloth.

Wood is blackened by the action of the acid, and at the same time softened and disintegrated. In damp weather the stain of this acid on wood is moist, unless the acid has been neutralized by an alkali.

On the skin the concentrated acid produces an intense, biting sensation, and soon blisters and destroys the cuticle, and to a greater or less extent corrodes the tissues underneath. If the acid is not removed at once, the spot turns brown; and even when it is washed away immediately, or its action neutralized by alkalis, the cuticle is destroyed and a red scar remains wherever the acid has acted. This acid, because it is so readily obtained, is the favorite of the acid thrower, who attempts to disfigure or blind his victim by throwing the fiery liquid over the face and person. A number of cases are reported yearly in which such attempts have been more or less successful. If the acid gets into the eyes, its corrosive action and the intense inflammation it sets up are almost sure seriously to impair the sight, and certainly to cause the most excruciating suffering.

Fatal results from sulphuric acid introduced into the body are numerous. Yet the acid has never been used in homicidal cases except when the intended victim has been incapable through age or condition of resisting the administration of the acid. For so intensely sour is its taste, and so suddenly corrosive its action, that in the very act of taking it, it is rejected. The results of taking it are therefore to be looked for in cases of suicide or accident. A number of such cases are reported, and some in which there has occurred a curious lack of early symptoms, the action of the acid seeming to be delayed by the presence of food in the stomach. Some cases are reported in which the acid has been taken by the vagina or rectum. In all these instances the corrosive action of the acid has been in evidence sooner or later.

When the concentrated acid is swallowed, there is at once the most intense pain in the mouth and throat. In many instances this sense of pain is so excruciating as to deprive the person of the power of motion, yet cases are recorded in which, after taking it, the person has walked or ridden a considerable distance. The pain quickly extends to the stomach, and there is continued vomiting of a thick, brown material, strongly acid and tinged with blood. The mouth becomes filled with a tough, stringy mucus, so that difficulty of swallowing and loss of speech speedily occur. The mouth and the tongue are greatly swollen and, at times, as though smeared with white paint, though after a time the color changes to gray or brown. The abdomen is very painful when touched, and is generally distended. All food is immediately rejected by the stomach and vomiting is usually incessant. The face is pale and anxious; the pulse is quick and feeble; the body cold and covered with a cold perspiration. There is no delirium. The bowels are constipated; the stools, if any, are more or less black and contain shreds of lining membrane. Death usually occurs within from eighteen to forty-eight hours, though it may occur from the secondary effects of the acid many months after the latter has been taken.

The treatment consists in the administration of dilute alkalis, by preference calcined magnesia, though in an emergency washing soda or even the plaster from the wall may be used to neutralize the acid, and, in case of the lack of all these, water should be given copiously. Mucilaginous and oily drinks should also be administered to aid in recovering the corroded surfaces. The stomach pump should not be used on account of the softened condition of the tissues. In cases of impending suffocation, which sometimes occurs from the swollen condition of the glottis or from the presence of a mass of stringy mucus, tracheotomy must be resorted to.

A post-mortem examination of a case, rapidly fatal, shows the mouth and tongue more or less corroded and covered with a white or brown coat, the œsophagus corroded and at times its lining membrane loosened entire in the form of a tube, or more commonly detached in shreds. The bronchial tubes are intensely inflamed. In some instances death has resulted from the effects of the acid on the organs of respiration alone. The stomach is intensely reddened, and its mucous surface may be brown, the blood-vessels beneath showing as dark lines through the action of the acid on the blood. Sometimes the stomach is perforated, the edges of the perforation being black and jagged, and the surrounding organs showing marks of inflammation. In cases of death from the remote effects of the acid, the appearance of the body is that of starvation. The glands of the stomach are found to be extensively destroyed and the stomach itself much contracted. Constriction of the stomach and œsophagus has also been found on post-mortem examination.

Recovery has taken place from so large a dose as three ounces, and death has resulted from forty drops, in the case of a child. The amount which will cause death depends so much on individual conditions that it is impossible to state what may be considered a fatal dose. Recovery from a case of sulphuric acid poisoning is not usual, though a number of cases of recovery have been reported.

The search for sulphuric acid in a case of death by its action may lead to negative results, as has been shown in a number of cases. This comes from the fact that most, if not all, of the acid is gotten rid of by the incessant vomiting, by its neutralization by the albuminous matters of the tissues, or by its elimination by the kidneys or bowels. In order to detect the acid, the vomited material or the stomach with its contents must be steeped in water for some time, the solution filtered, and the reaction of the filtrate tested with blue litmus paper. A slightly acid reaction is to be expected, even if no sulphuric acid is present, owing to the naturally occurring free hydrochloric acid in the gastric juice.

A portion of the filtrate is to be carefully evaporated to small bulk, and in it is to be placed a lump of white sugar. If any sulphuric acid is present, the sugar after a time will turn brown or black, according to the amount of acid present. If to a portion of the clear filtrate, made acid with hydrochloric acid, there is added a solution of barium chloride, a dense white precipitate of barium sulphate, insoluble in acids and alkalis, is formed at once, if sulphuric acid be present. The same precipitate will be formed whether free or combined sulphuric acid be present, and care must be taken not to base an opinion on the result of this test, unless it can be proven that the amount of barium chloride is in excess of that which would be present in the foods taken, or would correspond to a greater amount than that in any medicine administered. The quantity of sulphuric acid is readily calculated by collecting and washing the barium sulphate formed, and igniting it with the filter paper in a porcelain crucible, and then weighing the product after the crucible has become cold. Each 100 parts of the precipitate correspond to 42.06 parts of anhydrous sulphuric acid.

II. Nitric Acid.—Nitric acid or aqua fortis is not so common as sulphuric acid, and for this reason, and also because of its warning odor, it is not so liable as the other to be taken accidentally. A number of cases of suicide and some cases of accidental death have been traced to its use. Fatal results have followed both when the fumes have been inhaled and when the acid itself has been swallowed.

A number of forms of the acid occur.

First, a clear, colorless liquid having a specific gravity of 1.42, and containing 75 per cent. of the acid. This liquid fumes strongly in the air, and its vapor is suffocating.

Second, a colorless liquid having a specific gravity of 1.414, and containing 68 per cent. of the acid. This is the *Acidum nitricum* of the United States Pharmacopœia.

Third, a dilute acid, also clear and colorless, containing

10 per cent. of the real acid, the *Acidum nitricum dilutum* of the United States Pharmacopœia.

Fourth, a commercial acid of varying strength, yellow or brownish red in color and giving off irritating fumes.

All the colorless forms of the acid are decomposed by air and light, with the formation of oxides of nitrogen, and the liquids become colored through the solution of these oxides in the acid. In bottles partly full of nitric acid, the space above the liquid is also filled with the gaseous products of the decomposition of the acid.

The corrosive effects of nitric acid are much like those of sulphuric acid, with the differences that nitric acid has not so great an attraction for water and that it possesses the power to oxidize most organic substances with which it comes in contact. Further, it combines with albuminous substances, making a comparatively stable, yellow compound.

The vapor when inhaled produces a sense of suffocation and fullness in the head which is followed by a cough and by inflammation. These symptoms gradually pass away in most instances, though some cases are recorded in which death has followed the inhalation of the vapor of the acid.

When swallowed in concentrated form, there is at once an intensely severe, burning pain in the mouth and throat which extends soon to the stomach. The stomach is distended and there are eructations of a peculiar, sour-smelling gas. Vomiting usually occurs, the matters vomited being brown in color and generally containing dark brown blood. The mouth is filled with thick mucus and there is often almost complete loss of voice. Swallowing is intensely painful and often impossible. The process of breathing is interfered with on account of the swelling of the glottis and adjacent parts. Sometimes tracheotomy is necessary. The pulse is faint, quick, and irregular. The surface of the body is covered with a cold sweat, and there are frequent chills. The bowels are constipated, and in some cases the urine is suppressed. Toward the end, a stupor sometimes comes on, but the mind is generally clear. Death has taken place in an hour and a half from the primary effects, and from the secondary effects, after two years. Death is usually delayed from twelve to twenty-four hours.

The treatment consists in giving mild alkalies or alkaline carbonates to neutralize the corrosive effects; milk and mucilaginous drinks are also beneficial.

The quantity necessary to produce a fatal result varies, as in the case of the other mineral acids, according to many circumstances. Death has followed the swallowing of two drachms, and recovery has taken place after half an ounce has been swallowed.

The post-mortem appearances, when death has occurred within a short time after taking the acid, show a yellow or brown color on the mouth and lips, and the skin, where the acid may have fallen, is burned and easily detached. A yellowish or brownish, frothy liquid issues from the nose and mouth. The abdomen is usually distended, the membranes of the mouth are white or slightly yellow, the teeth are corroded, and sometimes there are yellowish stains at the junction of the teeth and gums. Marks of inflammation are present in the larynx also. The lining membrane of the œsophagus is softened and often easily detached in long strips. The lungs are congested. The stomach is inflamed and shows yellowish or brown patches or streaks. The muscular coats of the stomach are generally softened, but the organ is seldom perforated. The inflammation gradually decreases in intensity from the stomach downward, and the small intestines show only slight marks of the acid. In prolonged cases there are noted great contraction and marks of ulceration in the œsophagus and stomach. In some cases the stomach has been found with large scars, or almost obliterated, or attached to adjacent organs, with its cardiac and pyloric openings contracted to a mere thread. The body is emaciated, the person having died from starvation—a view which is borne out by the condition of the stomach and organs.

In case the patient has long survived, there is no use

to search in the dead body for indications of the acid. The most promising material for such investigation is, of course, the vomited matter, but if this be not available, the stomach and its contents, if any, may reveal the presence of the acid, provided death has followed the ingestion of the acid within a few hours.

In order to make the necessary tests for the presence of the acid, the materials at hand are treated with water at a gentle heat for some time. The mixture is then filtered and evaporated to small volume. Portions of the solution are then tested as follows:

First, test the reaction of the material with blue litmus. If the litmus is reddened, it shows the presence of an acid, which in this case may be nitric acid, hydrochloric acid, or lactic acid, or an acid salt.

Second, to a crystal of brucine in a porcelain dish add a small amount of the solution and warm. If free nitric acid is present, the crystal turns red.

Third, to a saturated solution of ferrous sulphate, add in a test tube a little of the suspected solution carefully, so as not to mix the two liquids. In a short time a brown or brownish-black line appears at the junction of the two liquids, if nitric acid is present. If alkalies have been administered, concentrated sulphuric acid must be added to the portion of the liquid used for this test, the mixture cooled, and the iron solution poured on this mixture.

Fourth, to a portion of the solution, hydrochloric acid is added, and a fragment of gold leaf. The solution is then carefully heated. If litric acid is present, a part of the gold, at least, will dissolve. The presence of the gold in solution may be proven by treating the liquid after filtration with stannous chloride, when in the presence of gold a purple coloration results.

Fifth, a portion of the liquid evaporated to small bulk is placed in a flask and to it is added some concentrated sulphuric acid. A strip of bibulous paper that has been dipped in boiled starch containing a little dissolved potassium iodide is suspended from a cork fitted to the mouth of the flask. After a time the paper is turned blue in the presence of nitric acid.

III. Hydrochloric Acid.—Hydrochloric or muriatic acid occurs in commerce in several forms:—

First, as a clear, colorless liquid that fumes strongly in the air, giving off suffocating vapors and absorbing water. The solution has a specific gravity of 1.20, and contains 40.8 per cent. of acid.

Second, as a clear solution, having a specific gravity of 1.16, and containing 31.9 per cent. of acid.

Third, as a clear liquid prepared from the preceding by dilution, and containing 10 per cent. of hydrochloric acid.

Fourth, as a yellow liquid containing a variable amount of the acid and colored yellow by iron. This acid also contains traces of arsenic and other impurities.

As in the case of the other acids, hydrochloric acid occasions serious consequences because of its corrosive nature, and is less active in proportion to its dilution. It is, however, the least corrosive of the common mineral acids, and, on account of the irrespirable gas given off, the concentrated acid is less liable than the others to be taken by accident or to be administered in homicidal cases.

When the strong acid is swallowed there is at once intense pain in the mouth, throat, and stomach, followed by vomiting with eructations of gas. In some cases a white vapor is also seen escaping from the mouth. The vomited matters have a strongly acid reaction, and are brown in color and sometimes streaked with blood. The pulse is feeble and quick, the breathing labored, and the surface of the body is cold and covered with perspiration. The mouth and throat appear white and swollen.

The treatment in cases of hydrochloric acid poisoning consists in the administration of dilute alkalies and mucilaginous and oily drinks. The carbonates are not to be used except as a last resort, on account of the softened condition of the stomach.

Recovery has occurred from a large dose of the acid,

and death has followed the taking of a small one. The amount necessarily fatal is unknown, the result depending more on bodily conditions and treatment than on the amount of the acid.

If the case proceeds rapidly to a fatal termination, the appearances at the post-mortem are generally as follows: The mouth, tongue, and throat are white and swollen, the epiglottis much enlarged, the œsophagus devoid of its lining membrane to a greater or less extent, or thrown into longitudinal folds and thickened. The lungs are inflamed and somewhat congested. The stomach shows the corrosive effects of the acid; its walls are much softened and sometimes present a charred appearance. The intestines also show marks of inflammation.

The detection of the acid, except in the materials first vomited, is extremely difficult, and complicated by the fact that there are present in the body normally a varying amount of chlorides and even of free hydrochloric acid. Tests of the material supposed to contain the acid are made by treating it with water for a considerable time and filtering the liquid. A portion of the filtrate is treated in a porcelain dish with a few drops of phloroglucin vanillin solution, made by dissolving 2 gm. of phloroglucin and 1 gm. vanillin in 30 c.c. of alcohol. On careful evaporation, a red line appears at the junction of the liquid and the dish.

The filtrate turns blue litmus red.

The concentrated liquid causes white fumes, if a glass rod dipped in concentrated ammonium hydrate be held near it.

A portion of the filtrate added to a solution of silver nitrate gives a white curdy precipitate, insoluble in acids, but readily soluble in ammonium hydrate. Hydrochloric acid, free or combined, gives this reaction, and the above test is of use only in case the amount of the precipitate is largely in excess of what might be due to the chlorides in foods and in the gastric juice. The above precipitate also furnishes a ready means of estimating the amount of the hydrochloric acid present, if the precipitate is carefully dried at 100° C. and weighed, each hundred parts corresponding to 25.43 parts of anhydrous hydrochloric acid.

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ACIDS, THERAPEUTIC ACTION OF.—In treating of the therapeutic action of acids, reference is directed to the stronger acids which possess all the chemical characters of this group in a marked degree. The most important are sulphuric, nitric, hydrochloric, phosphoric, acetic, citric, and tartaric acids. Of the vast host of other acids, represented by boric, benzoic, oleic, carbolic, salicylic acid, etc., the chemical characters of the true acid are either absent or gradually diminish until they are overshadowed by other important therapeutic properties.

When applied to the tissues, the local effect varies from the powerful corrosive action of sulphuric acid to the mild irritation of the vegetable acids. Sulphuric acid is destructive to all tissues, altering and destroying them beyond recognition. It is extremely hygroscopic, and this affinity for water is the cause of its great penetrating and diffused action. It combines with the albumin, fibrin, etc., producing a jelly-like mass which may be partially discolored and charred. The milder solutions simply coagulate and disorganize the albuminous structures. Nitric acid acts similarly, but is less severe. In addition to its corrosive effects, it produces a characteristic yellowish stain, which serves to distinguish it from other acids. A somewhat similar stain is caused by bromine and iodine, but marks of either of these are readily removed by a little caustic potash, while the nitric acid stain becomes of a brighter hue by the action of the alkali. Hydrochloric acid is very much weaker. It does not cause the same destruction of tissue as the other two acids, but the parts become white or whitish brown by its coagulation of the albumin; at times bullæ and blisters may form. On the soft mucous surfaces, the strong acid may produce a swollen; structureless mass. The other acids, with the exception of glacial acetic acid, are simple irritants.

When the acids are administered internally, the local effects are the same as when they are applied to the skin, but more severe on account of the greater delicacy of the tissues. In addition to the action upon the mucous membrane, they also act upon the secretions and upon the contents of the stomach. In medicinal doses, the beneficial effects of dilute acids are marked, but how far this is due to their local action or is secondary to action after absorption, is still an unsettled question. After absorption they lose their acid character, they combine with the alkaline bases in the blood, and render it less alkaline, but never produce acidity. They are excreted as sulphates, chlorides, etc. The presence of hydrochloric acid in the gastric juice is regarded as a true secretion of the gastric glands. As escharotics, acids are a useful adjunct to the therapeutic armamentarium. Sulphuric acid is not so much employed as it was formerly, when it was a favorite reagent for removing morbid growths. Its painful effects and great penetrating power are objectionable, and it is replaced by other caustics which are more easily controlled. This penetrating property, however, renders it, as well as nitric acid, of value in bites and wounds of poisonous animals. Nitric acid is always selected when any destruction of tissue is desired. Its value in syphilitic sores and phagedenic ulceration is well recognized. It removes the necrosed tissue and produces a healthy growth of granulations. Chromic acid and carbolic acid may be mentioned here. They are not true acids, but their caustic properties are frequently resorted to. Their action is more easily controlled, but, in the case of chromic acid in particular, evil effects may follow its absorption. Hydrochloric acid is seldom used, although it was at one time often employed to destroy the membrane in diphtheritic throats. The use of acetic acid is almost limited to the slow removal of warty growths and the treatment of ring-worms.

In weak solutions the acids become stimulating and disinfecting lotions. Nitric acid has been found of service in indolent ulcers and wounds, and in cystitis. Hydrochloric acid is employed for the same purpose in the anginas of scarlet fever and diphtheria. In very dilute solutions all acids possess a cooling and refreshing action when applied to the surface of the body; they also exert an astringent effect upon the blood-vessels and sweat glands, as when employed to prevent or lessen the night sweats of phthisis. Nitromuriatic acid baths and compresses have been extolled as a means of relieving the hepatitis of hot climates.

When administered as a beverage all acids are most refreshing. This is well known in all tropical countries. Lemonade, lime juice, dilute phosphoric, acetic, citric, and tartaric acids are universally employed. Their effervescing salts are particularly useful. The treatment of fevers by the continuous employment of acids has many disciples. They prove refrigerant and disinfectant, promote digestion, and if there is any diarrhoeal tendency, their astringent properties become of service. The vegetable acids, either pure or in combination, have a more relaxing effect and promote excretion by the emunctories.

Beaumont Small.

ACNE.—DEFINITION.—Acne may be defined as a disease of the sebaceous glands of the skin and of the follicles of the lanugo hairs attached to them, thus being both a folliculitis and a perifolliculitis. It is characterized by their inflammation and suppuration, and often by their destruction, with a resulting scar.

The term acne has been qualified in accordance with various salient features presented by its lesions or with certain clinical characteristics predominant in a case, and there are therefore found in literature such terms as acne vulgaris, pustulosa, punctata, juvenilis, adolescentium, etc. All, however, represent the same process. In addition to these, the name acne has also been applied to a large number of affections, which have nothing whatever in common with true acne, but which represent totally different pathological entities, and among these are included tuberculous affections, drug

eruptions (iodine and bromine acne), or folliculitides of artificial origin (tar, oils, and grease, etc). For the sake of simplicity and definiteness, the disease will be treated of here under the heading of acne simplex—the more superficial form—and of acne indurata—the deeper-seated variety. Acne rosacea, being a compound process, will receive separate mention.

SYMPTOMATOLOGY.—*Acne Simplex.*—Acne simplex possibly represents the most common form of the disease, as it is the one developing particularly about the age of puberty and in young people. Instances have also been seen at a much earlier age, and likewise later in life, about the climacteric. Apparently, it occurs more often in the female than in the male sex, but the ratio between them is probably more relative than exact. The lesions characterizing the affection occur without regularity or symmetry, though they are usually distributed bilaterally. Still, variations are met with, such as one side of the face being intensely attacked, and the other side only slightly, and sometimes it is found unilateral. Acne occurs on the face especially, but it also often appears on the chest and shoulders, and sometimes on the upper arms, or it extends down the back even to the thighs.

The lesions characterizing acne simplex are, comedones, papules, and pustules. In this variety of the disease, the comedo, or popularly the blackhead, as a rule constitutes a central point around which the inflammatory changes take place. These can usually be seen and traced in every case, and consist of redness around the comedo, then formation of a papule, and lastly transformation into a pustule. Lesions may, however, arise independently of the comedo. The lesion having become pustular, remains as such for a few days; the redness then begins to fade and a crust forms, which falls off in the course of a few days or more, leaving a slight stain, or a pitting. The pustular transformation does not, however, take place in all of the lesions. Many of them having reached the papular stage, remain in that form for a variable length of time and then gradually undergo involution. Neither do all the comedones become implicated and result in papules or pustules, but many persist *in situ* unchanged. In consequence, on an affected surface all stages of the disease are usually met with, and

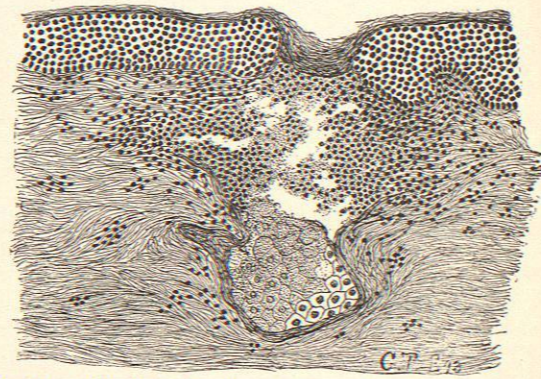


FIG. 12.—Section through a Superficial Acne Lesion (Acne Simplex). (Author's drawing.)

comedones, papules, pustules, crusts, stains, and scars are seen more or less aggregated together without order or regularity, the whole constituting the condition known under the name of "pimply skin" or "pimples."

The lesions of acne simplex present no especial subjective symptoms, though when handled the inflamed ones are sometimes slightly painful. Occasionally a burning sensation or itching is complained of.

The scars and stains resulting from the lesions vary in degree, in number, and in size. In many cases, no scars are produced and the subsidence of the inflammatory



ACNE SIMPLEX, SHOWING COMEDONES, PAPULES AND PUSTULES.
(FROM THE COLLECTION OF PHOTOGRAPHS OF DR. GEORGE HENRY FOX.)