Prosperity and poverty, sobriety and intemperance, cleanliness and filth, seem to exert no appreciable influence in warding off the disease or in favoring its development. These influences, however, when once the disease has become established, may turn its further course toward the better or toward the worse.

The disease does not appear to have any depressing influence upon the general health. Often it constitutes simply a bodily discomfort, with perhaps, in addition, a certain amount of mental worry consequent upon its presence.

Etiology.—As to the cause of psoriasis, we know nothing positively. There are many theories. In some respects the disease behaves as if it were due to germ influence, the manifestations resembling somewhat those of an exaggerated action of the ringworm fungi—as, for example, the peripheral extension, the frequent clearing up at the centre, and the persistent activity at the border. Psoriasis presents a further resemblance to a parasitic disease in the character of its relapses; it being an easy matter to ascribe them to re-infection from small uncured points, such as can always be found on some part of the body.

Course of the Disease.—Recurrences are the rule; often the central parts of the pale patches left after the subsidence of an outbreak are the sites of a new eruption. These relapses often occur immediately or very soon after the subsidence of an acute outbreak. It is probable that a person affected with psoriasis is never absolutely free from the disease after the first onset. I have been able to follow one such case for a period of over ten years—that is, from the time when the patient was only three and a half years of age to that when he was fourteen years old. It is interesting to note that this patient has always been strong and robust and that he has been in no way retarded in his development.

Diagnosis.—The diagnosis of psoriasis should offer little difficulty, if the features already described are kept in mind. In the following paragraphs I will mention briefly the characteristics which should enable the physician to distinguish it from the various affections with which it is most likely to be confounded.

Dry seborrhœa of the scalp shows little if any inflammation or thickening. The scales in this affection are smaller than those observed in psoriasis, and if they are present in a mass the latter is usually more friable; often, too, these scales form sheaths around the hairs at their insertion in the follicles. Removal of the masses of scales may show a reddening beneath and a slight moisture.

Seborrhœic eczema of the scalp usually shows fewer scales; if there are patches they are thinner and slightly moist, and the scales are greasy. When the disease extends from the scalp upon the forehead it may resemble psoriasis, but there is little infiltration, the scales are not dry and papery, and the inflamed surface presents a somewhat more moist appearance.

Syphilis of the scalp may show the so-called corona or frontal extension. The color is, however, of a deeper shade, the infiltration more marked, and the scales are smaller, more adherent, less papery looking, and less abundant. Syphilitic patches on the scalp lack the features which have already been described as characteristic of psoriasis.

Ringworm of the scalp is dry, scaly, not infiltrated in any marked degree, has fewer, finer scales, and shows a well-marked, not greatly elevated border which bears evidence of slight exudation. The hairs in the patch are broken or lustreless from the growth of the micro-organism.

Eczema of the scalp does not occur in the form of sharply limited patches; then, besides, there is a peculiar stiffening and thickening of the parts affected, and there is either a frank, sticky exudation upon the surface or there are points and lines of broken epidermis where the exudation is just beginning to break forth. Upon drying, the exudation assumes the form of gummy, brownish, or yellowish crusts.

Seborrhœic eczema on the body shows scarcely any infiltration, the scales are few and often greasy, and the affected surface has not the absolute dryness of psoriasis.

Syphilitic patches of the dryest form, when located elsewhere than on the scalp, often show a tint of lividity, and they have a less regular shape than the patches of psoriasis; the scales also are smaller and less plentiful, and they are formed at a less rapid rate than in the latter disease.

In none of the diseases enumerated above can the punctate hemorrhage be produced.

When compared with psoriasis even the dryest eczema of the body shows less symmetry of lesions, more thickening, a less well-defined border, fewer scales, and these not like the scales of psoriasis. Furthermore, the patches have a stiffer look and feel, and itching is more marked.

Ringworm of the body shows fewer scales, and less, if any, thickening of the part affected. On the other hand, the lesion has a sharply defined border, which appears to be the seat of an exudative inflammation. At the centre of the lesion the skin is generally found to be nearly free from inflammatory action.

When psoriasis is associated with other morbid conditions of the skin the physician will have to base his diagnosis upon the presence of certain features which are characteristic of this disease.

Prognosis.—The prognosis of psoriasis is unfavorable as regards a cure, and doubtful as regards the removal of the eruption. In all my experience I have seen but one case of psoriasis—at least so diagnosed—in which recovery was perfect; but even in this case it is not perfectly clear that an error in diagnosis may not have been made, for upon reading my notes of the case again at the present time I find that it may possibly have been one of a slightly atypical seborrhœic eczema. Recovery followed the use of treatment administered on the supposition that the case was one of psoriasis. This patient was a woman in good circumstances who died of alcoholism.

It is best to promise a patient with psoriasis nothing more than a certain amount of relief.

Treatment.—The treatment of psoriasis is both external and internal, the former being the more efficacious of the two. Arsenic has been for years the chief reliance in the internal treatment of the disease, it being often pushed to large dosage and continued for long periods of time. Its effects show such a mixture of good and evil that I seriously question whether the benefits of the remedy are not more than offset by its disadvantages. Some people reach the limit of tolerance (conjunctival irritation, puffiness of lids, gastric irritation) very early. If they escape these, they may, under a long-continued use of the drug, acquire other dermatoses scarcely preferable to psoriasis. However, it is well to give arsenic a trial, but only in cases in which there is but a small degree of cutaneous irritation. It is usually employed in the form of Fowler's solution (liquor potass. arsenit.); the dose being, for an adult, five drops after each meal. This dose should be gradually increased (an additional drop at the end of every twenty-four hours) until the limit of tolerance is reached.

Another arsenical preparation is what is called "Asiatic pills," the formula for which is as follows: ℞ Acid. arsenios., gr. i.; piper. nigris, gr. xx.; pil. mas. q.s. M. ft. pill. xx. Sig.: Begin with one after each meal; increase by one every day. As a result of taking these pills, some patients have complained of stomachic irritation which they, quite reasonably, attributed to the black pepper, this irritation preventing in itself the object sought—viz., to obviate irritation by the arsenic.

Iodide of potassium administered in large doses has acquired considerable renown as a means of relief for psoriasis, but my experience with this drug has been of such a discouraging character that I have given it up in the treatment of this disease.

Thyroid extract, in the form of tablets (gr. ij.–x. t. i. d.), has seemed, by actual comparison with other remedies, to be decidedly beneficial; it constitutes, perhaps, our best remedy for use internally in the treatment of psoriasis. This opinion is at variance with that of excellent authorities, but is entirely sustained by my observation. All depends upon obtaining the pure, and therefore not inert, substance. As thyroid extract is capable of inducing depression of the heart's action and possibly dizziness, the dose must be small at first, the effect watched, and it may even be necessary to attempt to neutralize these effects by the administration of strychnine.

As is self-evident, the patient's general condition must be kept at its best by such internal treatment as the symptoms may require, just as if there were no psoriasis.

Faithful following of directions as to external treatment, while onerous, must be required. The first requisite is the removal of scales to permit the action of remedies. Naturally, the treatment generally outlined below is to be much modified if the skin is found to be abnormally irritable.

Hot baths at night, in combination with the liberal use of soap, greatly assist in removing the scales. Sapo viridis may be used in full strength for removing scales, or an alcoholic solution (sap. vir., ʒ ij.; alcohol, ʒ i.) may be employed; but any strong soap will do quite as well. As alkalies exert a special effect upon epidermic scales it is easy to understand the beneficial action of soaps in removing them in psoriasis. Hot tar baths or tar well rubbed into the patches before an ordinary hot bath is taken will often be found helpful.

To aid in the removal of accumulated scales from the scalp, it is advisable to apply freely a mixture containing salicylic acid and olive oil in the proportion of one part of the former to eight of the latter. After the mixture has been well rubbed in, it should be allowed to soak into the parts for some time before it is finally washed away. The addition of formalin to this mixture (two and a half minims to each ounce) seems to heighten its beneficial effect. If a milder application is desired, the addition of twenty grains of salicylic acid to one ounce of simple ointment will be found to answer satisfactorily.

In my own experience with the treatment of psoriasis of the scalp, the ammoniate of mercury, preferably in salve form, has proven the most useful remedy. The following are some of the formulæ used: (1) ℞ Hg. ammoniat., ʒ ss.–i.; Ung. simp. (seu. Ung. aq. ros.), ʒ i. M. Rub well in at night. (2) ℞ Ung. hg. ammon., ol. oliv., āā ʒ ss. M. Sig.: Use at night. If there is not much irritation, Ung. hg. ammon. (U. S. P.) may also be used.

These mercurial preparations can be employed only on a limited portion of the general cutaneous surface, as there is always some risk of inducing salivation if the drug is too extensively applied.

I have used the following, but it produced slight ptyalism: ℞ Hg. ammon., gr. xl.; acid. salicyl., ʒ i.; Ung. zn. ox., ʒ i. M. Sig.: Apply well morning and night. This ointment may be considered perfectly safe if it is applied over a limited area.

When there is a more general involvement of the skin, chrysarobin in salve form is the best local remedy. Chrysophanic acid is much weaker in its action, and I have abandoned its use. Chrysarobin usually exerts its best action when its characteristic dermatitis is produced. Under its action the skin becomes deep red, almost lilac in color, hot, and itches. The subsiding, clearing patches stand out as gray-white and uninflamed upon this reddened surface. The proneness of chrysarobin to cause irritation precludes its use on the scalp or face, for fear that this irritation may involve the eyes.

The most useful salve is the following: ℞ Chrysarobin, ʒ ss.–ij.; Ung. zn. ox., ʒ i. M. Sig.: Rub well in patches freed of scales at night—leave some on. To this may be added acid. salicylic., ʒ ss.–i., which often increases its effect.

The varnishes so frequently employed in affections of the skin seem to interfere with the action of the drugs contained, but occasionally a varnish containing chrysophanic acid has proved somewhat beneficial in the treatment of psoriasis.

The following formulæ have been found useful: (1) ℞ Chrysarobin., gr. xv.–ʒ i.; liq. gutt. perchæ, ʒ i. M. Sig.: Shake. Paint on patches freed of scales. (2) ℞ Acid. chrysophanic., ʒ i.; collodii flex., ʒ i. M. Sig.: Paint on. (3) ℞ Chrysarobin., ʒ i.; collodii, ʒ i. M.

Lanolin, when used as the base, makes a more adhesive ointment, but the zinc oxide salve seems to prevent severe irritation. It is customary to suspend the chrysarobin treatment upon the appearance of marked dermatitis, but if this is not severe the use of the drug may be continued. To relieve this dermatitis, one of the following preparations may be employed after suspending the chrysarobin: (1) ℞ Zn. ox. pulv., ʒ iv.; phenol. (ninety-five per cent.), ʒ i.; amyli pulv., ʒ ij.; aq., ʒ iv. M. Sig.: Shake; apply often. (2) ℞ Zn. ox. pulv., ʒ ij.; amyli pulv., ʒ i.; ol. oliv., ʒ ij. M. Sig.: Shake: apply.

Pyrogallic acid at one time was considered a good second to chrysarobin as regards its efficacy in the treatment of psoriasis; and it may still be found an efficient remedy. The following is a suitable form in which it may be employed: ℞ Acid. pyrogallic., ʒ ss.–ij.; Ung. zn. ox., ʒ i. M. Sig.: Use in the same manner as the chrysarobin ointment, and in those cases in which the chrysarobin ointment proves too irritating.

The tar preparations have proven useful in some cases, especially where the skin will not bear stronger treatment. The following are convenient formulæ: (1) ℞ Ol. cadenii, ʒ ij.; acid. pyrogallic., ʒ i.; ether. sulphuric., alcohol, āā ʒ i. M. Sig.: Apply night and morning. (2) ℞ Picis liq., ʒ i.–ij.; Ung. zn. ox., Ung. diachyli., āā ʒ ss. (or omit the diachylon). M. Sig.: Rub well in once or twice a day. Leave on. (3) ℞ Picis liquid., ʒ iij.–iv.; acid. salicyl., ʒ i.; Ung. zn. ox., ʒ iv. M. Sig.: Apply in the usual manner.

In the employment of these different remedial procedures it is well to remember that a lotion must be re-applied so often that the parts will be kept constantly covered with the fluid; that a varnish must be re-applied as soon as it peels off; that a salve must be well rubbed in, and a sufficient quantity must always be left on to keep the drugs in continuous action upon the skin; and, finally, that soap and baths and other scale-removing measures must be employed often enough for the attainment of the object desired. Then, when all this has been done, the patient will probably still have some psoriasis, or a new attack will supersede the old one, and the only certain hope of an end to the disease is such as is offered by his decease.

M. B. Hutchins.

PTERYGIUM. See *Conjunctiva, Diseases of.*

PTOMAÏNS.—Ptomaïns are basic, nitrogenous organic substances produced by bacteria.

The first writer to suggest the probability of the formation of a poison coming within the above definition during putrefaction seems to have been Kastner (*Arch. f. gesam. Naturlehre*, 1824, Bd. i., 448, 488; Bd. ii., 499), who advanced the hypothesis that poisonous sausages contained an "alkaloid of decay" (*Moderalkaloid*) combined with an organic acid.

In 1852 Schlossberger, in an extended paper upon the sausage poison (*Arch. f. physiol. Heilk.*, Ergänzhft., 1852) supposed "the poisonous substances occurring in sausages and cheese to be organic bases, which have their origin in the decomposition of the protein materials rich in nitrogen, under certain conditions." He supported this hypothesis by the following observations: (1) When ammonia is produced in considerable amount by the decomposition of animal or vegetable substances, it is accompanied by volatile bases; (2) by the action of dilute potash upon poisonous sausages, much ammonia, accompanied by a peculiar repulsive odor, is given off; (3) the physiological action of the putrid poison is very similar to those of the known volatile alkaloids nicotin, coniïn, sparteïn, and to those of the artificial amid, imid, and nitril bases of Hofmann; (4) one of these bases, trimethylamin, is contained in herring pickle.

Four years later (1856) Panum was probably the first to obtain a ptomaïn, although in an impure condition, and to demonstrate that the putrid poison is a chemical

substance and not a living organism ("Bibl. for Laeger.," 1856; *Schmidt's Jahrb.*, 1859, ci., 213; *Arch. f. path. Anat.*, 1874, lx., 328–352). This substance was described by Panum as being soluble in water, from which it was precipitable by alcohol; capable of extraction from putrid meat, and not identical with any of the known odorous products of putrefaction. It is capable of withstanding a boiling temperature, evaporation, and the influence of absolute alcohol, conditions inconsistent with the presence of organized life.

In 1866 Bence Jones and Dupré obtained from animal matters a substance which they called "animal chinoidine," which gave precipitates with the general reagents for the alkaloids then known, and whose solution exhibited a blue fluorescence (*Med. Times and Gaz.*, 1866, 163). In 1868 Bergmann and Schmiedeberg obtained from putrid blood a small quantity of a crystalline substance, which was poisonous to dogs and to frogs, and to which the name "sepsine" was applied (*Med. Centralbl.*, 1869, 497). In 1869 Zuelzer and Sonnenschein obtained from cadavers a crystalline substance having physiological actions resembling those of atropin (*Berl. klin. Wochenschr.*, 1869, vi., 121).

Between 1872 and 1878 Selmi published an extended series of observations upon the reactions and properties of putrid products, without, however, having determined their chemical composition; and in 1875 proposed the name "ptomaïn," written by some recent German authors, "ptomatine," derived from the Greek, πτῶμα, *i.e.*, that which is fallen; a corpse. The contributions of Selmi and his Italian followers—Morrigia and Battistini, Trottarelli, Raffaele, Ziino, Albertoni and Lussana, Paterno, Spica, Brugnatelli and Zenoni, Bocci, Guareschi and Mosso, and Monari—have been numerous and important. It remained, however, for Nencki and his pupil Brieger to determine the chemical character of these compounds. The former was the first to establish the composition of a ptomaïn by the analysis of a base having the formula $C_5H_{11}N$, probably *a*-phenyl-ethylamin, in 1876. The latter, in the most important researches upon the chemistry of the ptomaïns ("Ueber Ptomaine," i., 1885; ii., 1885; iii., 1886; *Berl. klin. Wochenschr.*, 1890, xxvii., 241, 267, 1133), established the constitution of a number of the putrid bases.

The ptomaïns have been, and still are, frequently referred to as "animal alkaloids," a designation which is misleading and improper for two reasons: They are not necessarily produced from animal substances, but many are formed by putrefaction of vegetable proteins; nor are they usually the products of animal metabolism, as are their relatives, the leucomaïns. Only a few of them are known to be alkaloids in the present acceptation of the term, *i.e.*, basic substances derived from heterocyclic nuclei containing but one nitrogen atom in any nucleus. The great majority, and those best known, are of much simpler molecular structure, and are monamins, diamins, guanidins, hydramins, betaïns, or amido-acids. It will be observed, therefore, that the designation "ptomaïn" applies, not to the individuals of a distinct class of chemical compounds, but rather to the bacterial origin of members of several different chemical functions, which may also be produced by synthetic methods, having in common only the two qualities that they contain nitrogen and are basic. Strict regard for the derivation of the name would limit its applicability to ptomaïns produced by saprophytic bacteria, either outside of the living body or within it, as in intestinal putrefaction or in gangrene; but it is now applied also to the basic products of parasitic bacteria, the "toxins" of Brieger.

Some of the ptomaïns, as the diamins and the lower terms of the monamin series, are either non-poisonous or poisonous only in very large doses. Others, and notably those formed by pathogenic bacteria, are actively poisonous. When it had been found that pathogenic bacteria produced in culture media and in the living body definite basic substances, such as Brieger's tetanin, which, when injected into animals, produced symptoms similar to those caused by the bacteria themselves, it was inferred that the manifestations of the disease were caused by these ptomaïns. It has been shown, however, that the basic substances obtained from cultures of the tetanus bacilli, for example, are vastly inferior in toxic potency to the bacteria-free cultures themselves. The inference is plain that the bacteria produce other substances more actively toxic than the ptomaïns, and it is now considered as proven that the basic bacterial products play but a secondary part in the production of the manifestations of disease caused by bacteria, while these other substances, the "toxins," concerning whose chemistry but little is known, beyond the facts that they are non-basic, and that some are possibly proteins, while others are certainly not, are the essential bacterial poisons.

While the toxins are in all probability synthetic products, the ptomaïns are undoubtedly decomposition products derived from the proteins or from complex phosphorus-containing organic substances, either by simple cleavage or by hydrolysis, and many of them are thus produced from the parent substances by agencies other than bacterial life. Cholin is thus produced from the lecithins by hydrolysis by barium hydroxid; the amido acids and indole and skatole are similarly formed from the proteins; the pyridin bases are found in oil of Dippel, produced by the dry distillation of bones; and arginin, the most abundant of the hexon bases, formed by the action of hydrochloric acid and tin chlorid upon the proteins, yields putrescin on further decomposition.

As the process of putrefaction is a gradual and progressive one, different basic products are produced at different stages, and bases obtainable in considerable amount during the first days of putrefaction will have more or less completely disappeared at a later stage, when other bases, not previously present, will have made their appearance. The nature of the bases (as well as of other products) produced varies also with those conditions which modify the progress and nature of putrefactive changes, viz.: (1) The kind of bacteria, particularly whether aërobic or anaërobic, and, consequently, the access or non-access of air; (2) the nature of the protein undergoing decomposition; (3) the temperature; (4) the degree of moisture. It is also probable that in cadaveric putrefaction the nature of the ptomaïns produced is influenced by the results of the simultaneous changes which the carbohydrate and fatty constituents undergo; as, for example, in the formation of adipocere.

As the ptomaïns represent several different classes of chemical compounds, no general characters other than those above indicated can be ascribed to them. Nor can it be expected that they should exhibit any qualities or reactions which could serve to distinguish them as a class from other compounds.

Although the chemical constitution of many of the ptomaïns remains to be determined, that of quite a number has been established, sufficient to warrant their classification, so far as possible, according to chemical function. Such a classification is here attempted.

Monamins.—*Methylamin*, $CH_3.NH_2$, and *dimethylamin*, $(CH_3)_2:NH$, gases, and *trimethylamin* $(CH_3)_3:N$, a liquid, boiling point 9°, have long been known to exist in herring brine, and together constitute the greater part of the commercial "trimethylamin," prepared by distillation of beet-sugar vinasse. They are also formed during the decomposition of fish and of a number of other animal and vegetable substances. Trimethylamin occurs naturally in, or is easily liberated from, cod-liver oil, ergot, chenopodium, yeast, guano, human urine, the blood of the calf, and many flowers. It probably originates from the decomposition of cholin (see below), from which it may be obtained, along with glycol, by the action of caustic potash: $CH_2OH.CH_2N::(OH)(CH_3)_3 = CH_2OH.CH_2OH + N(CH_3)_3$. All three of these bases have the odor of stale fish, are very soluble in water, forming strongly alkaline solutions of hydroxids, and soluble, deliquescent hydrochlorids. Each forms a platinochlorid, easily soluble in hot but sparingly soluble in cold water, and a readily soluble aurochlorid. They are practically non-poisonous.

Ethylamin, $C_2H_5.NH_2$, *diethylamin* $(C_2H_5)_2:NH$, and *triethylamin* $(C_2H_5)_3N$, are strongly alkaline, oily liquids, boiling points, 18°, 56°, 89°, which accompany the methylamins in herring pickle, beet-sugar vinasse, and the products of putrid fish, yeast, and gluten. Their hydrochlorids and platinochlorids are easily soluble in water. They are practically non-poisonous.

Propylamin, probably the iso-compound $(CH_3)_2:CH.NH_2$, boiling point 32°, *butylamin* (iso?), $(CH_3)_2:CH.CH_2.NH_2$, boiling point 68°, *iso-amylamin*, $(CH_3)_2:CH.CH_2.CH_2.NH_2$, boiling point 95°, and a *hexylamin* $(CH_3)_2:CH.(CH_2)_3.NH_2$, are colorless, strongly alkaline liquids occurring in cod-liver oil, beet-sugar vinasse, and decomposing yeast. The amyl compound is actively poisonous.

Nencki's base, $C_5H_{11}N$, obtained from a mixture of pancreas and gelatin after five days' putrefaction at 40°, seems to have been *β*-phenyl-ethylamin, $C_6H_5.CH_2.CH_2.NH_2$, boiling point 197°. The free base is oily, has a peculiar, not disagreeable odor, absorbs carbon dioxid from the air to form a crystalline carbonate, and forms a sparingly soluble platinochlorid, crystallizing in long flat prisms. Its aurochlorid is a yellow oil, which is rapidly decomposed by reduction. A base, probably identical with this, is formed by decomposition of *β*-phenyl-*a*-amido propionic acid, or phenyl alanin, $C_6H_5.CH_2.CH(NH_2).COOH$, itself a product of putrefaction (see below).

Mydin, $C_5H_{11}NO$, is a base obtained by Brieger from human cadaveric matter which had been in putrefaction four months at a temperature from + 5° to − 9° in closed vessels. The free base is strongly alkaline, has an ammoniacal odor, and is a strong reducing agent, and therefore forms no stable aurochlorid. Its platinochlorid is very soluble. This base is believed to be *β*-oxyphenylethylamin, $HO.C_6H_4.CH_2.CH_2.NH_2$, derived from the decomposition of tyrosin, which is p-oxyphenyl-alanin, $HO.C_6H_4.CH_2.CH(NH_2).COOH$, by loss of CO_2.

Diamins.—*Tetramethylenediamin*, $H_2N.CH_2.CH_2.CH_2.CH_2.NH_2$; *putrescin*—is one of several diamins which were found by Brieger to be products of putrefaction. It is formed, along with penta- and hexamethylenediamin, during the putrefaction of fish, muscular tissue, gelatin, and other animal tissues, appearing about the third day and increasing in quantity for two to three weeks. It is found in the urine and fæces in cystinuria, in amounts proportionate to the quantity of cystin eliminated (diaminuria), and also in cholera stools. Putrescin has been shown to be a diamin, and to be identical with the tetramethylenediamin synthetically prepared by Ladenburg's method, although with methyl iodid it yields only a tetramethylated derivative, but no hexamethylated derivative. The origin of putrescin from the proteins occurs through the hexon base arginin (*δ*-guanidin-*a*-amido valerianic acid: $HN:(NH_2):.C.NH.CH_2.CH_2.CH_2.CH(NH_2).COOH$, which is formed from the proteins by tryptic digestion. Arginin is split by hydrolysis into urea and ornithin (*δ*-*a*-diamido valerianic acid), and ornithin has in turn been converted into putrescin, by loss of carbon dioxid, by bacterial action: $CH_2(NH_2).CH_2.CH_2.CH(NH_2).COOH = H_2N.CH_2.CH_2.CH_2.CH_2.NH_2 + CO_2$. Putrescin and other diamins may be separated from most other substances by taking advantage of the formation of the insoluble dibenzoyl compounds which they form with benzoyl chlorid in presence of alkalies; a property which they share with polyatomic alcohols and aldo- and keto-alcohols. Its dibenzoyl compound crystallizes in plates or needles, difficultly soluble in alcohol, insoluble in water.

The free base is a clear, rather thin liquid, boiling point 156°–157°, having a disagreeable, seminal odor, strongly alkaline, and absorbing carbon dioxid from the air. Its hydrochlorid crystallizes in colorless needles, soluble in water, insoluble in absolute alcohol, not hygroscopic. Its platinochlorid and aurochlorid both form hexagonal plates, difficultly soluble in cold, more soluble in hot water. Its picrate crystallizes in needles, sparingly soluble in water or in cold alcohol, soluble in hot alcohol. It is practically non-poisonous.

Pentamethylenediamin, $H_2N.(CH_2)_5.NH_2$, *cadaverin*, is another diamin found by Brieger to accompany putrescin as a product of putrefaction of muscular tissue, heart, lung, liver, and other animal protein material, from the third day to four months. It also accompanies putrescin in the urine and fæces in cystinuria, and in cholera stools. It has been found in the intestinal contents in a case of intestinal fistula, and is probably a normal product of tryptic digestion, although it is not found in normal fæces. It has been shown to be identical with the normal pentamethylenediamin (formula above) prepared by Ladenburg's method. Cadaverin originates through the hexon base, lysin (probably *a*-*ε*-diamido caproic acid, $CH_2(NH_2).(CH_2)_3.CH(NH_2).COOH$, from which it is produced by putrefaction, as putrescin is formed from arginin. Cadaverin is a thick, transparent liquid, having a very disagreeable odor, somewhat resembling that of coniïn; boils at 175°; fumes, and absorbs carbon dioxid rapidly when exposed to air, being converted into a crystalline compound. With methyl iodid it forms a dimethylated derivative. Its hydrochlorid is crystalline, deliquescent, readily soluble in water and in dilute alcohol, but insoluble in absolute alcohol and in ether. On dry distillation it spiits off hydrochloric acid and ammonium chlorid and forms piperidin: $C_5H_{14}N_2.2HCl = HCl + NH_4Cl + C_5H_{11}N$, an instance of the pyrogenic origin of a cyclic from an acyclic compound, of an alkaloid from an amin. Its platinochlorid forms needles or short rhombic prisms, soluble in alcohol, difficultly soluble in water. Its aurochlorid crystallizes in cubes, needles, or plates, easily soluble in water. Its picrate forms plates, soluble in hot water, sparingly soluble in cold water or in alcohol. Its dibenzoyl compound crystallizes in needles, soluble in alcohol, insoluble in water. With potassium chromate and sulfuric acid it gives a reddish-brown, evanescent precipitate. It is practically non-poisonous.

Neuridin, $H_2N.(C_5H_{10}).NH_2$, another of Brieger's diamins, is isomeric with cadaverin, but of unknown constitution. When heated with caustic potash it yields dimethylamin and trimethylamin, a decomposition which shows it to be not identical with amylamin, with which it is also isomeric. Indeed, there are twelve possible isomeres of this amin. Neuridin is produced, along with cholin, during the first stages of putrefaction, particularly of gelatinoid substances, and increases in quantity as putrefaction advances, while the quantity of cholin diminishes. It is no longer present after fourteen days. The free base is gelatinous, and decomposes even during evaporation of its solution. It has a disagreeable, spermatic odor, and is insoluble in absolute alcohol and in ether, difficultly soluble in amylic alcohol, readily soluble in water. It forms white precipitates with mercuric chlorid and with neutral and basic lead acetate. Its hydrochlorid crystallizes in long needles, and is very soluble in water, insoluble in alcohol, ether, chloroform, petroleum-ether, benzene, or amylic alcohol, except in presence of other animal substances, when it dissolves in the immiscible solvents mentioned. Its platinochlorid forms flat needles, soluble in water, insoluble in alcohol. Its aurochlorid crystallizes in short needles, difficultly soluble in cold water. Its picrate forms needles, almost insoluble in water, sparingly soluble in alcohol. When pure it is non-poisonous.

Saprin is another diamin, formed along with putrescin, cadaverin, and mydaleïn, during the putrefaction of glandular tissues. Brieger assigned to it the formula $C_5H_{12}N_2$, but it is now believed to be isomeric with cadaverin and neuridin, $C_5H_{14}N_2$. It is distinguished from cadaverin by the greater solubility and different crystalline form of its platinochlorid, by the absence of an aurochlorid, by the permanence of its hydrochlorid in air, and by its failure to give the reaction with potassium chromate and sulfuric acid. It is non-poisonous.

Hexamethylenediamin, $H_2N.(CH_2)_6.NH_2$, is formed during putrefaction of muscular tissue and pancreas. It

is a crystalline solid, fusing at 40° and boiling at 195°. Its platinochlorid forms rhombic needles, soluble in water, sparingly soluble in alcohol.

Brieger's base, $C_2H_8N_2$, isomeric but not identical with ethylenediamin, $H_2N.(CH_2)_2.NH_2$, and supposed to be *ethylidenediamin*, $CH_3.CH(NH_2)_2$, was obtained from putrefying fish. Its hydrochlorid crystallizes in long, brilliant needles, easily soluble in water, insoluble in absolute alcohol. It does not form an aurochlorid. Its platinochlorid crystallizes in small scales, sparingly soluble in water. This base, administered hypodermically in small quantity to mice and guinea-pigs, produces in a short time increased secretion of the nasal mucus, saliva, and tears, which are subsequently temporarily arrested, to begin again later. The pupils are dilated and the globes protruded. There is marked dyspnœa, which continues until the death of the animal, within twenty-four hours.

Another base was obtained by Brieger in very small quantity from cultures of the comma bacillus, which may possibly be *trimethylenediamin*, $H_2N.(CH_2)_3.NH_2$.

Mydalein was obtained by Brieger in small quantity after seven days' exposure to air of putrefying viscera, and increased in amount up to three weeks. The amount obtained was insufficient to determine its composition further than that its platinochlorid contained Pt 38.74, C 10.83, H 3.23 per cent., from which the inference is drawn that it is a diamin, probably containing four or five carbon atoms. Its hydrochlorid crystallizes with great difficulty, and is very hygroscopic. Its platinochlorid forms needles, very soluble in water.

This base is actively poisonous. In small doses in rabbits and guinea-pigs it causes greatly increased nasal and lachrymal secretion, dilatation and insensibility of the pupils, increased body temperature, acceleration of respiration and cardiac action, a tendency to sleep, and increased peristalsis. With larger doses (less than 0.005 gm.) the increased secretions become very profuse, the pupils are widely dilated, and the eyes protruded. The animal falls, the posterior extremities being first paralyzed, then the anterior, and there occur fibrillar spasms of various groups of muscles. Sometimes the animal springs up and immediately falls, making faint movements of the legs. The respiration, at first very frequent, becomes slow and labored. The body temperature diminishes gradually, the movements become more and more faint, and the animal dies in a condition of sopor. The heart is arrested in diastole, and the intestines and bladder are found contracted after death.

Spermin, C_2H_5N(?), a base of uncertain composition, but probably an imin, has been obtained from semen, testicles, ovaries, thyroid, pancreas, and spleen, and from cultures of the comma bacillus. Its phosphate forms crystals, known as Leyden, Böttcher's, or Charcot's crystals, which are met with in anatomical preparations preserved in alcohol, in dried semen, in sputa and nasal secretions, in the blood, spleen, and other organs of leucocythæmics and anæmics, and in fæces. These crystals are insoluble in alcohol, ether, or chloroform, difficultly soluble in water, easily soluble in dilute acids or alkalies. The free base forms crystals, which rapidly absorb carbon dioxid from the air, are readily soluble in water and in alcohol, insoluble in ether, and strongly alkaline in reaction. Its hydrochlorid crystallizes in hexagonal prisms, very soluble in water, insoluble in absolute alcohol or ether. Its platinochlorid crystallizes in plates, its aurochlorid in prisms. It is non-poisonous.

Triamins.—Guanidin or carbotriamin, $HN:C:(NH_2)_2$, is formed by oxidation of guanin, but is not a ptomaïn. Its methyl derivative, *Methyl-guanidin* or *methyl-uramin*, $HN:C:(NH_2)(NH.CH_3)$, which is a product of oxidation of creatin and of creatinin, was obtained by Brieger from horseflesh which had undergone putrefaction at a low temperature and without exposure to air for four months, and it has since been obtained from the cultures of several species of bacilli. It is undoubtedly derived from creatin, to which it is closely related. It is a colorless, imperfectly crystalline, highly hygroscopic and strongly alkaline base. Its hydrochlorid crystallizes in prisms, insoluble in alcohol. Its platinochlorid forms very soluble needles. Its aurochlorid crystallizes in short rhombic prisms, soluble in ether, sparingly soluble in water and in alcohol. Its picrate crystallizes in needles, sparingly soluble in water, which fuse at 192°.

In guinea-pigs methylguanidin causes copious diarrhœa and increased secretion of urine. The pupils are dilated and insensible to light. The animal remains in one position, even when irritated, but soon becomes restless and seeks to move the anterior extremities, while the posterior are paralyzed. The respiration becomes progressively deeper and more labored, and there is marked dyspnœa. The legs become paralyzed, and the animal falls on its side and dies, after short, general clonic convulsions. After death the heart is found in diastole the intestine filled with fluid, the bladder contracted, the cortical portion of the kidneys hyperæmic, and the papillary portion pale.

Hydramins (*Oxyamins*).—These are derivatives of the dihydric alcohols, retaining one hydroxyl, and containing one amido group, more or less modified by substitution. The ptomaïns of this class are trimethylated quarternary ammonium hydroxids.

Cholin, $(CH_2OH).CH_2.N::(CH_3)_3(OH)$, *trimethyloxethylammonium hydroxid*, was originally obtained by Strecker from ox bile in 1849, and was subsequently shown by Diakonow to be derived from the lecithins, which, when hydrolyzed, yield cholin, phosphoglyceric acid, and fatty acids. It is now known to be very widely distributed in both animal and vegetable organisms, and it is one of the first of the ptomaïns to be produced by a number of bacteria, having its origin undoubtedly in the decomposition of the lecithins, which occur in almost all animal tissues, and are very prone to decomposition. As putrefaction advances, cholin gradually disappears, partly by conversion into neurin, or possibly into muscarin, and partly by more complete decomposition, with formation of trimethylamin, until after seven days it is no longer present. Cholin is a syrupy, highly alkaline liquid soluble in all proportions in water, which absorbs carbon dioxid rapidly from air, with formation of a crystalline carbonate. Its chlorid forms highly deliquescent needles, very soluble in water and in alcohol, insoluble in ether, chloroform, or benzene. Its platinochlorid crystallizes in prisms or in plates, readily soluble in water, insoluble in alcohol or ether. Its aurochlorid crystallizes in prisms, soluble in hot water or in alcohol, almost insoluble in cold water. Its picrate forms needles, soluble in water and in alcohol. It is not poisonous except in large doses, when it produces effects similar to those of muscarin.

Neurin, $CH_2:CH.N::(CH_3)_3(OH)$, *trimethylvinylammonium hydroxid*, an unsaturated compound, differing from cholin by H_2O less, was obtained by Liebreich from protagon, and has been obtained from brain tissue and suprarenal capsule, and by the action of boiling baryta water upon cholin. It was found by Brieger, along with neuridin, in the products of putrefaction of horseflesh for five or six days at the temperature of incubation. It may originate by dehydration of cholin or by decomposition of lecithins, in whose constitution it replaces cholin, the existence of which is probable. The free base is a syrupy, highly alkaline liquid, soluble in water in all proportions, and decomposed by boiling of its aqueous solution, with liberation of trimethylamin. Its chlorid crystallizes in needles, hygroscopic, and very soluble in water and in alcohol. Its platinochlorid forms octahedra, almost insoluble in water. Its aurochlorid crystallizes in prisms, difficultly soluble in water. Its picrate forms long needles, sparingly soluble in water and in alcohol.

It is actively poisonous, producing effects resembling those of muscarin. When administered to rabbits it causes movements of mastication, accompanied by profuse secretion of saliva, which is at first thick and viscid, then thin and alkaline. The increased secretion of saliva continues until the terminaton of the poisoning, and varies in degree with the magnitude of the dose. Subsequently there is increased secretion from the Schneiderian mucous membrane and the lachrymal glands, the latter of short duration. The respiratory movements are at first more frequent and deeper than normal; the extraordinary respiratory muscles are brought into action, the head is thrown back, and the nostrils are dilated. These symptoms of dyspnœa alter in character as death approaches, in that the movements become irregular, superficial, and less frequent. The heart's action immediately after the injection is accelerated, so that the pulse cannot be counted; in a short time it becomes slower, and diminishes constantly in frequency. The pulsations are at first very strong, but subsequently become progressively weaker until the heart is arrested in complete diastole. The heart's action continues after cessation of respiration. Section of the vagi has no influence, and the heart responds to artificial stimuli. Occasionally contraction of the pupils occurs, an effect which almost always follows an application of a strong solution of the poison to the eye. Powerful peristalsis is an early symptom, causing an uninterrupted voiding of matters, at first consistent, subsequently watery. Ejaculation and dripping of urine also occur. If the abdomen be opened at this stage, tetanic contractions of greater or lesser portions of the intestine are seen. The spleen is also strongly contracted. Only when lethal doses are given do strong clonic convulsions occur, in which the animal soon dies. These convulsions are partially controlled by artificial respiration, but they soon recur. Locomotion is interfered with, the posterior extremities being first paralyzed, then the anterior, before the beginning of the convulsions. In cats there is an increased secretion of alkaline perspiration. Atropin is a powerful antidote; but atropinized animals are still subject to the action of the poison. When taken by the mouth this alkaloid produces the same effects as when administered hypodermically, but ten times the dose is required.

Muscarin (?), $C_5H_{15}NO_3$, a base having the above composition, and corresponding in physiological action to the muscarin which occurs in toadstools (agaricus, boletus, amanita), was obtained by Brieger from putrefying fish. It forms a deliquescent, difficultly crystallizable chlorid; a platinochlorid which crystallizes in sparingly soluble octahedra; and an aurochlorid which forms needles, also difficultly soluble in water. It is not certain that this base is identical with the muscarin of fungi, or that either is identical with the "synthetic muscarin" obtained by oxidation of cholin. The last named undoubtedly has the constitution sometimes assigned to oxycholin, and expressed by the formula $CH_2OH.CHOH.N::(CH_3)_3(OH)$, from its derivation from cholin: $CH_2OH.CH_2.N::(CH_3)_3(OH)$.

Brieger's ptomaïn, administered in very small quantities to frogs, causes total paralysis, and arrest of the heart in diastole. The administration of atropin to frogs under the influence of this base revives the action of the heart, and the effects of the ptomaïn are not observed in atropinized animals. Minute doses, administered to rabbits, cause greatly increased salivary and lachrymal secretions, contraction of the pupils, profuse diarrhœa, ejaculation, voiding of urine, and death after convulsions of short duration.

Betaïns.—These compounds, closely related to the hydramins, are anhydrids, or, more properly, lactams, derived from acids corresponding to the hydramins, such as $(COOH).CH_2.N::(CH_3)_3(OH)$ (see cholin), by elimination of H from COOH and OH from the ammonium hydroxid group. Thus:

Betaïn or *trimethylacetic betaïn*— $\begin{array}{l} COO \\ | \quad \diagdown \\ CH_2.N:.(CH_3)_3 \end{array}$, is ranked as a ptomaïn because of its occurrence in fresh poisonous muscles (which undoubtedly owe their toxicity to bacterial action) and among the products of putrefying gluten. It was first obtained from beet root (whence its name), and also exists in malt, in cotton seed, and in a number of other vegetables; and is formed by several synthetic methods, as by the interaction of monochloracetic acid and trimethylamin.

It forms large, deliquescent crystals, with one molecule of water of crystallization, very soluble in water and alcohol. It is strongly basic and forms crystalline salts. Heat decomposes it, with evolution of trimethylamin. Its chlorid forms non-deliquescent plates, insoluble in absolute alcohol. Its platinochlorid forms soluble prisms; and its aurochlorid sparingly soluble plates or needles. It is non-poisonous.

Mydatoxin, $C_6H_{13}NO_2$, which may be *trimethylpropionic betaïn*, $\begin{array}{l} COO \\ | \quad \diagdown \\ CH_2.CH_2.N:.(CH_3)_3 \end{array}$, or the corresponding iso-compound, was obtained by Brieger from decomposing horseflesh under the same conditions as mydin. The free base is a strongly alkaline syrup, which crystallizes *in vacuo*, insoluble in alcohol and ether, decomposed by distillation. Its chlorid is a thin, colorless syrup, which forms no double salt with auric chlorid, and with platinic chlorid a very soluble double salt which fuses and is decomposed at 193°.

Mydatoxin is not very actively poisonous. Administered subcutaneously to guinea-pigs, the chlorid of this base causes increase in the frequency of the respiration; at first contraction, and later dilatation and insensibility, of the pupils; and diminution of temperature with short chills. Clonic convulsions, frequently of such intensity that the animal is involuntarily projected forward, recur at short intervals. The secretions of the salivary and lachrymal glands become more abundant. The body temperature falls, and the respiration becomes less frequent. The ears, at first injected, become pale and cold. The extremities are paralyzed. The cardiac action becomes irregular and less frequent. Convulsions are provoked by striking upon the table supporting the animal. Shortly before death the convulsions become less strong, the extremities are extended, the animal falls upon its side and dies. After death the heart is found arrested in diastole, the intestines are strongly contracted, and the bladder is empty and contracted.

Mytilitoxin $C_6H_{15}NO_2$, a base of undetermined constitution but also possibly a betaïn, was obtained by Brieger from the poisonous mussels which caused the poisonings at Wilhelmshaven. The free base has a disagreeable odor which it loses on exposure to air and at the same time becomes non-poisonous. It is decomposed by heating with caustic potash. Its chlorid crystallizes in tetrahedra and is intensely poisonous, causing the same symptoms as do the mussels (see Vol. IV., p. 189). The aurochlorid crystallizes in microscopic cubes which fuse at 182°.

Amido Acids.—The amido acids, formed by substitution of one or more amido groups (NH_2) for hydrogen in the hydrocarbon groups of other acids, are not usually considered as ptomaïns, probably because they were known as products of the decomposition of proteins, by putrefaction or otherwise, long before Selmi suggested the name "ptomaïn" for substances which he considered to be alkaloidal. Thus tyrosin was found to be a product of decomposition of casein by Liebig in 1846; and Proust discovered leucin as a product of putrefaction of gluten and of cheese in 1819. But these bodies contain nitrogen, and, although they are acids by virtue of their carboxyl groups (COOH), they are also distinctly basic, by virtue of their amido groups. They therefore come within the limitations of the class of ptomaïns as given above. Among the diamido acids are included substances, such as lysin and ornithin, and among their guanidin derivatives substances, such as arginin and probably histidin, which, although not ptomaïns, so far as is known, are products of the earlier steps in the decomposition of the proteins, and intermediate in the generation of some, at least, of the ptomaïns.

The amido acids of the acetic series may be obtained synthetically, either by the action of ammonia upon the monochloro derivatives of the acids, or by the action of nascent hydrogen upon the cyano derivatives, as well as

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Ptomaïns.
Ptomaïns.