flammation, and fever, presents a coherency which is worthy of your attention. Thus:

Mechanical objects injure the common tissue; and the process of repair arises.

Errors in diet disorder the plasma; and inflammation appears.

Miasms in the air affect the corpuscles of blood; and primary fever is the result.

Both the process of repair and inflammation, from hindrances and difficulties, may pass into chronic or protracted forms of suppuration, ulceration, and discharges; whereupon, if spoiled material should enter the circulation, and, by reiteration or quantity, thoroughly debase the plasma, the corpuscles suffer, and fever appears; namely, reactionary, hectic, or a plasma fever.

A Course of Lectures

ON

URINE, URINARY DEPOSITS, AND CALCULI.

DELIVERED AT THE PATHOLOGICAL LABORATORY, DURING THE SESSION 1857-58.

BY

LIONEL BEALE, M.B., F.R.S.,

PHYSICIAN TO KING'S COLLEGE HOSPITAL; PROFESSOR OF PHYSIOLOGY AND GENERAL AND MORBID ANATOMY IN KING'S COLLEGE, LONDON; ETC.

LECTURE II.

Healthy Urine. I. VOLATILE CONSTITUENTS. II. ORGANIC CONSTITUENTS. III. INORGANIC CONSTITUENTS.—VOLATILE CONSTITUENTS: *Water; Carbonic Acid; Peculiar Organic Acids; Ammonia and Ammoniacal Salts.*—ORGANIC CONSTITUENTS: *Urea; Quantity; Characters; Circumstances affecting the Formation of Urea; Origin: Creatine: Creatinine: Guanine: Sarcine: Inosite: Uric Acid; Quantity; Detection; Mode of Formation: Urates: Hippuric Acid: Extractive Matters: Mucus: Lactic Acid and Lactates.*

[*Concluded from page* 386.]

Creatine exists in small quantity in urine. Its presence in this secretion was discovered by Heintz. Dr. Thudichum has obtained from 3·45 to 6·32 grains of creatine from the urine of a healthy man in twenty-four hours. Creatine has a pungent taste, is very soluble in hot water, but requires about seventy-five parts of cold water for its solution. It is very slightly soluble in alcohol, and quite insoluble in ether. It crystallises in right rectangular prisms and rhomboidal crystals. (*Illustrations of Urine*, Pl. VII, Fig. 3.) By being boiled with baryta water, it is converted into urea and sarcosine; with strong acids, into creatinine.

Creatine may be obtained from urine by the following process, proposed by Liebig. Lime water and chloride of calcium are first added to the urine, which is then filtered and concentrated by evaporation, in order to remove most of the salts. The liquid from which the salts have been separated is decomposed with one-twenty-fourth of its weight of a syrupy solution of chloride of zinc. After the lapse of some days, a number of round granules make their appearance. These consist of chloride of zinc and creatinine, with which creatine is mixed. (*Illustrations of Urine*, Pl. VII, Figs. 1 and 2.) They are dissolved in hot water, and treated with hydrated oxide of lead until the reaction is alkaline. The oxide of zinc and chloride of lead are to be removed by filtration; and, after being decolorised by animal charcoal, the solution is evaporated to dryness. The residue is to be treated with boiling alcohol, which dissolves the creatinine very readily, but leaves the creatine, which may be recrystallised by solution in hot water.

Creatine is obtained from all kinds of lean meat, but exists in larger proportion in that of mammalia than in birds, reptiles, and fishes. Gregory obtained ·14 from 100 parts of bullocks' heart, ·08 in 100 parts of pigeons' flesh, and ·06 in the same quantity of the flesh of the skate. Although the flesh of fishes contains less creatine than that of the higher animals, it is more favourable for extraction. I obtained more than seventeen grains of creatine from two pounds of the flesh of the crocodile. The presence of creatine has been detected in the blood by Verdeil and Marcet. Traces of it have been discovered in the amniotic fluid.

Its existence in the juice of muscular tissue, and its presence in the urine, would lead to the conclusion that creatine was one of the nitrogenised products resulting from the disintegration of muscular tissue; and such a view of its nature is supported by the readiness with which it is decomposed into urea, creatinine, and sarcosine. It is found in greater quantity in muscles which have been in active exercise during life, than in those which have been quiescent. The heart yields a large quantity; and more is found in animals which have been hunted to death, than in those destroyed without being subjected to violent exercise. Creatine may, like urea, be regarded as an excrementitious substance.

Creatinine is also crystalline. The crystals take the form of right rectangular prisms, according to Robin and Verdeil. It has a strongly alkaline reaction, and is soluble in water. It is very soluble in warm alcohol. It combines with different acids to form salts. With chloride of zinc, a crystalline compound is formed, composed of roundish wart-like masses, made up of minute radiating crystals, which have been already referred to.

Creatinine is found in the urine in larger proportion than creatine, and must be considered as an excrementitious substance. It is not destroyed in the decomposition of urine, while the creatine undergoes conversion into creatinine. Dr. Thudichum obtained as much as from five and a half to nearly ten grains of creatinine from the urine of a healthy man in twenty-four hours.

Guanine, Sarcine, Inosite. Strahl and Lieberkühn have discovered a substance in urine which they considered to be xanthine, but which, from its behaviour with reagents, may probably be regarded as guanine. Strecker has detected in urine a substance closely resembling sarcine, found in muscular fibre; but its exact nature is at present doubtful. Inosite has been found in the urine of a man suffering from Bright's disease by Cloëtta, but it has not yet been detected in healthy urine.

Uric Acid. The organic constituent of the urine which ranks next in importance to urea is uric or lithic acid. In healthy urine, its presence cannot be detected, unless a small quantity of a stronger acid, as nitric or hydrochloric, be first added to decompose the soluble urates. After the mixture has been allowed to stand for some time, the uric acid separates in the form of small red crystalline grains, which adhere to the sides of the glass vessel. Upon microscopical examination, these are found sometimes to be composed of separate crystals, and sometimes of small stellate groups; the individual crystals varying in form from the lozenge-shape to that of an elongated crystal with sharply pointed extremities. (*Illustrations*, Pl. IV, Figs. 2, 3, 4, and 5.) Uric acid is a very weak acid, and is perfectly separated from its salts by acetic acid. It is soluble in solutions of alkaline lactates, acetates, carbonates, phosphates, and borates. Uric acid has the power of decomposing the alkaline phosphates. It takes a part of the base, forming a urate, and leaves an acid phosphate, as I mentioned when speaking of the acid reaction of urine. The colour of the crystals of uric acid which have been obtained from urine is derived from the proper colouring matters of the secretion, and must, therefore, be regarded as an impurity. It can easily be obtained perfectly pure and colourless; and, in three or four instances, I have observed perfectly colourless crystals of this substance, which have separated spontaneously from urine holding in solution scarcely a trace of colouring matter.

Pure uric acid crystallises in the form of very thin rhomboidal laminæ; but the sides of the crystals, instead of being perfectly straight, are usually more or less curved. The angles, again, are often rounded, so that the crystal has an oval form. In Plate IV, Figs. 2 and 5, and Plate V, Fig. 7, of the *Illustrations*, some pure crystals of uric acid are represented. Some of these crystals were obtained by the addition of acid to the solution. Although uric acid may be perfectly pure, the crystals vary much in size and form. Experiments show what very slight variations in the conditions under which they are produced are sufficient to determine great alterations in the form of the crystal.

Quantity. Healthy urine contains from half a grain to a grain of uric acid in 1,000 grains of urine. The solid matter contains about 1·3 per cent. of this substance, and probably from five to eight grains are excreted by a healthy adult man in twenty-four hours. Dr. Thudichum gives the latter as the average quantity.

Detection. The chemical characters of uric acid are well marked.

1. If to a deposit consisting of uric acid, placed on a glass slide, a drop of nitric acid be added, a brisk effervescence en-

sues; and when the mixture is slowly evaporated over a lamp, a reddish residue is left. Upon the addition of a drop of ammonia, a rich purple tint is produced, owing to the formation of murexide, the so called purpurate of ammonia. This test is exceedingly delicate: it was first applied by Dr. Prout. One other substance possesses a similar reaction, and this is caffeine; but uric acid is at once distinguished from it by its microscopical characters.

2. The deposit suspected to contain uric acid or a urate may be dissolved in a drop of solution of potash, in which it is very soluble. Upon adding excess of acetic acid, and leaving the mixture for some hours, small crystals of uric acid will form. These may be recognised by their microscopical characters.

3. Uric acid may be detected in animal fluids, when mere traces of this substance or of urates are present, by a plan proposed by Dr. Garrod. The fluid suspected to contain the urate is treated with a few drops of strong acetic acid (glacial acetic acid is best) in a watch-glass. A few filaments of tow or very thin silk are placed in the mixture, and the whole set aside under a glass shade, in a warm place, for twenty-four or forty-eight hours. Gradually uric acid crystals are separated, and deposited upon the filaments. Their characters may be recognised by microscopical examination. Some crystals of uric acid upon a hair are represented in Plate XXI, Fig. 6, of the *Illustrations*.

The quantity of uric acid is estimated by collecting the crystals separated by the addition of an acid, and weighing them after they have been carefully washed and dried. Dr. Thudichum recommends the use of nitric acid, because the uric acid is less soluble in it, and there is not so much tendency to the development of fungi as if hydrochloric be employed.

Mode of Formation. Uric acid is found in the urine of most carnivorous animals, and in that of young herbivora while sucking, and therefore feeding upon a diet rich in nitrogen. It is not found in the urine of the pachydermata, not even in that of the omnivorous pig. It is abundant in the urine of birds, and is found in that of many reptiles and insects. Uric acid exists in the blood, and is only *separated* from that fluid by the kidneys. Dr. Garrod has detected it in the blood of men in health, and in cases of gout in considerable quantity. In such instances, uric acid crystals may be separated from the fluid obtained from a blister, according to the plan I just described. It has been detected in the juice of the spleen in considerable quantity by Scherer, but Mr. Gray has failed to confirm these observations. Cloëtta has found it in the pulmonary tissue of bullocks' lungs, associated with taurine, inosite, and leucine.

Uric acid is one of the products resulting from the disintegration of albuminous tissues. Prout held "that a very large proportion of the urate of ammonia found in the urine on common occasions appears to be developed from the imperfect albuminous matters formed during the assimilating processes". This is rendered probable by the researches of later observers, especially by those of Bidder and Schmidt. In the healthy organism, it is probable that the greater quantity of the uric acid formed is soon afterwards further oxidised and converted into other compounds, especially urea; but, in certain conditions of the system, these changes do not take place to the full extent, or a much larger proportion of uric acid is formed. In either case, this substance exists in largely increased quantity in the blood. It is deposited, in combination with soda and lime, in various structures. It may accumulate beneath the skin, so as to form large collections, which are familiar to us under the name of chalk-stones. It is curious that these depositions should take place in areolar tissue, in white fibrous tissue, and in connexion with cartilage. Perhaps this may be connected with the very slight vascularity of these tissues; and it must be borne in mind that the deposits usually occur at a time of life when they are fully formed, after which they probably undergo very slight changes, and the processes concerned in their decay and regeneration are slowly, and perhaps, in sedentary persons, very imperfectly carried on. All these circumstances would favour the separation of a slightly soluble substance from the blood, and its deposition in an insoluble state. Lehmann has shown that, after attacks of disturbed digestion, the proportion of uric acid in the urine becomes increased. Alcoholic liquors seem to have the same effect. In normal conditions of the system, the urine contains about 1 part of uric acid to 28 or 30 parts of urea; but, under the circumstances just mentioned, the ratio becomes 1 to 23 or 26. This increased proportion of uric acid appears to be formed in consequence of the usual proportion not being converted into urea. In all cases where imperfect oxidation takes place in the organism, the quantity of uric acid excreted in the urine undergoes an increase. Alcohol causes a diminution in the quantity of carbonic acid exhaled; and, in such cases, an increased proportion of uric acid, urates, and usually oxalates, is found in the urine.

A highly nitrogenised diet, with insufficient exercise—confinement in ill-ventilated rooms—all circumstances interfering with the healthy action of the respiratory apparatus—or preventing the proper amount of blood being carried to the pulmonary surface, active exercise in confined air, etc.,—are conditions favourable to the formation of an increased quantity of uric acid and urates. The formation of urea and oxalic acid from uric acid in the organism, or artificially by the action of peroxide of lead, has been previously alluded to. Ranke has shown that, at a high temperature, in the presence of yeast and an alkali, uric acid also becomes converted into urea and oxalic acid.

Urates. Uric acid is separated from the blood by the kidneys, in the form of a urate, which is readily soluble in water. After its separation, however, this salt may soon undergo decomposition, and insoluble uric acid will be deposited. In the majority of cases, this decomposition does not take place until after the urine has left the bladder; but sometimes it occurs in the bladder itself. The causes of the precipitation of uric acid are well worthy of attentive study, as they are intimately connected with the formation of uric acid calculi. The quantity of urates in healthy urine is very small, but not unfrequently enough is present to form a very abundant deposit after the urine has been allowed to stand for some time. I propose to describe the characters, and allude to the composition, of these salts, when we consider the subject of urinary deposits.

Hippuric Acid was first detected in horses' urine by Liebig, and was proved by him to exist in healthy human urine in small quantity—a statement which has been confirmed by Lehmann, and recently by Kühne and Hallwachs. It is not found in the urine of carnivorous animals, but among herbivora it occurs in considerable quantity. It does not exist in large quantity in the urine of calves while sucking, but cows' urine contains as much as 1·3 per cent. Lehmann has detected it in considerable quantity in the urine of the tortoise (*testudo græca*).

Hippuric acid is soluble in about six hundred times its weight of cold water. It is very soluble in hot water, and also in alcohol; but is insoluble in ether. It crystallises very readily in various forms, which are derived from the right rhombic prism. (*Illustrations of Urine*, Plate IX, Fig. 1.) It is very easily decomposed into benzoic acid, especially in the presence of extractive matters, and other constituents of the urine. In testing for this substance, the perfectly fresh urine only should be employed. It is curious that benzoic acid, when taken into the organism, is eliminated in the urine in the form of hippuric acid—a fact which was first made known by Mr. Ure.

It may be prepared by adding milk of lime to fresh cows' urine. The mixture is to be boiled for a few minutes, strained, and exactly neutralised with hydrochloric acid. The solution is next to be boiled down to one-eighth of its original bulk, and considerable excess of hydrochloric acid added, when brown crystals of the acid form. These may be purified by solution in water, through which a current of chlorine is to be transmitted, in order to decolorise the liquid. It may always be readily obtained from human urine after taking ten grains of benzoic acid.

The quantity of hippuric acid is increased when a purely vegetable diet is taken; but it is certain that the whole of the hippuric acid formed in the organism is not derived from this source. The proportion of hippuric acid in human urine was formerly considered to be so small that it was scarcely possible to make a satisfactory quantitative determination; but Hallwachs has lately shown that as much as *thirty grains* or upwards are excreted in twenty-four hours.

Very little is known with reference to the formation of hippuric acid; and, although the subject has been very carefully investigated by Kühne and Hallwachs, who have published two very elaborate memoirs, there still remains much to be discovered. These observers hold that the hippuric acid is produced from the glycocol formed in the liver. Hallwachs is led to conclude, from numerous experiments, that the production of hippuric acid is determined rather by the chemical changes going on in the organism, than by any peculiarities of the food; for, if a purely animal diet was taken, hippuric acid was still found in the urine.* Lehmann found much hippuric acid in the urine of fever patients, and always detected it in diabetic urine.

Robin and Verdeil give drawings of some crystals which they found in the urine of a man aged 30, who took little exercise, but lived on a highly nitrogenised diet; and which they considered to be hippuric acid: a statement apparently founded upon their resemblance to crystals produced by the decomposition of hippurate of soda. They do not mention that the crystals were subjected to any chemical examination; and, in the absence of stronger evidence than mere resemblance in form, it seems to me that we are hardly justified in assuming that the crystals were composed of hippuric acid. It is very doubtful if this acid ever crystallises in urine spontaneously.

Extractive Matters. Under the head of extractive matters are included certain organic substances which have never been obtained in a state of perfect purity, which are uncrystallisable —not volatile without decomposition—and incapable of being isolated. Chemists have described several kinds of extractive matters characterised by their behaviour with solutions of acetate of lead, bichloride of mercury, tincture of galls, etc. Within the last few years, however, several bodies, formerly included under the indefinite term of extractive matters, have been separated, and their chemical properties accurately determined. As instances, I need only mention albuminate of soda, binoxide and teroxide of protein, creatin and creatinine, hippuric acid, lactic acid and lactates, and certain colouring matters. The extractive matters in urine are entirely excrementitious; but it seems most probable that those present in the blood represent a certain stage of the metamorphosis of some of the constituents of that fluid—either a state intermediate between the nutritive pabulum and the tissue into which it is to be converted (progressive metamorphosis or histogenesis), or a condition resulting from the disintegration of tissue previous to its elimination from the body in the form of urea, creatine, uric acid, etc. (regressive metamorphosis or histolysis). The extractive matters of urine may be divided into three kinds.

Water Extract. The first is called water extract, because it is insoluble in absolute alcohol, and in spirit of specific gravity ·833, but is soluble in water. It exists only in small quantity. Infusion of galls and bichloride of mercury produce scarcely any effect upon it, but neutral and basic acetates of lead give copious precipitates.

Spirit Extract. The second kind of extractive matter is termed spirit extract, because it is insoluble in absolute alcohol, but soluble in water, and in spirit ·833. It contains much chloride of sodium. The solution of this extract is unaffected by infusion of galls, bichloride of mercury, and neutral acetate of lead; but a bulky precipitate is caused by basic acetate of lead.

Alcohol Extract. The alcohol extract is soluble in water, in spirit ·833, and also in absolute alcohol. Its chemical reaction appears to be very similar to the last.

These are the extractive matters which are met with in healthy urine. In certain diseases, however, extractives drain off from the blood, and sometimes in very large quantity, which are not present in a state of health. My friend Dr. G. O. Rees many years since showed that this extractive could be detected in morbid urine by adding tincture of galls; and that the proportion varied greatly in different cases. Healthy urine is scarcely affected by tincture of galls, but this blood-extractive is at once precipitated by it. In order to detect it, tincture of galls is to be added to the filtered fluid; and, if this extractive is present, a precipitate is *at once* produced. Should the urine contain albumen, this must, in the first instance, be separated by boiling and filtration. It is only the precipitate which *immediately* follows the addition of the tincture of galls that must be noticed. In some cases, the extractive drains away from the blood, without the escape of albumen. (Lettsomian Lectures, by G. O. Rees, M.D., F.R.S.; *Medical Gazette*, 1851.) I shall have occasion to recur again to this interesting subject, when discussing the characters of the urine in disease.

One thousand grains of healthy urine will contain from fifteen to twenty grains of extractive matters. The solid matter contains from 15 to 40 per cent. of these substances.

The physiological importance of extractive matters is quite unknown, and hitherto no one has been able to ascertain their nature or discover the part which they play in the animal economy. Their presence in the blood, and in all the animal fluids, as well as in the solid organs and in the excretions, clearly prove them to be substances of great importance; and it must be remembered that, in the urine, the proportion of extractive matter is often greater than that of the urea itself. The amount of extractive matters in the different fluids and secretions of the body is a subject well worthy of investigation, and likely to yield valuable results.

Vesical Mucus. Vesical mucus exists in very small quantity in healthy urine. It forms a faint flocculent cloud, which settles towards the lower part of the fluid, after the specimen has been allowed to stand for some time. Under the microscope, it is seen to consist of granules, with a little epithelial *débris*, nuclei, and a few imperfectly formed epithelial cells. I shall have to allude to the nature of the so-called mucus-corpuscle when speaking of pus.

Lactic Acid. Lactic acid is not constantly present in healthy urine in quantities sufficient to be recognised; but sometimes it is found in the urine of persons who may be considered to be in tolerably good health. Liebig denied its existence in healthy urine altogether; but its presence in this fluid—at least, under certain physiological conditions, as stated many years ago by Berzelius—has been confirmed by Franz Simon, Lehmann, and others: although, on the other hand, it appears nearly certain that the salt assumed to be lactate of zinc by many observers was not really of this nature, but probably consisted of a combination of another acid, which, unlike lactic acid, contains nitrogen.

In order to ascertain the presence of lactic acid, a baryta salt should be first prepared, as Lehmann has recommended, from which a lime salt is easily formed by the addition of sulphate of lime. The lactate of lime crystallises in double brushes, as seen by the microscope. From the lime salt a copper salt is prepared by the addition of sulphate of copper. (*The Microscope, in its Application to Clinical Medicine*, 2nd edit., Figs. 123, 124, p. 123.) This is examined by the microscope. The lactate of copper is decomposed by placing a small bar of zinc in the solution; and upon this, in a short time, crystals of lactate of zinc are deposited, whose angles may be measured in the microscope. (*The Microscope*, etc., 2nd edit., Fig. 125, p. 123.) For the details of this process, I must refer to Lehmann's *Physiological Chemistry*, translated by Day, vol. i, p. 91.

According to some observers, the phosphate of lime and the ammoniaco-magnesian phosphate are held in solution by the lactic acid. They may also be dissolved by the chloride of ammonia, according to Dr. G. O. Rees. MM. Cass and Henry have endeavoured to prove that the lactic acid exists in the form of lactate of urea. Lactates of soda and ammonia are also most probably present in the majority of cases. Lactic acid is occasionally met with in urine; and I have already referred to some other organic acids which are sometimes found.

Before we discuss the characters of the saline constituents of healthy urine, it is desirable to consider how a specimen of urine may be systematically examined.

Systematic Qualitative or Quantitative Analysis of Healthy Urine: Organic Constituents.

1. In the first place, the reaction and specific gravity of the specimen are to be taken, and any general points noticed. (Lecture I.)

2. Two portions of urine (500 or 1,000 grains) are to be placed in separate porcelain capsules, and evaporated to dryness with the cautions previously given. In the first portion, A, the *organic constituents* are to be estimated; in the second, B, the proportion of *salts* is to be ascertained.* A, when dry, is to be weighed; and thus the quantity of *water* is obtained. The residue is known to be quite dry when *two successive* weighings exactly correspond. The solid matter is to be treated with successive portions of boiling alcohol, until nothing more is taken up. These are decanted into another basin, or passed through a filter; and the alcoholic solution, containing urea and extractives, is to be evaporated nearly to dryness—alcohol extract—C; the residue insoluble in alcohol—D.

C. The alcohol extract is to be treated with a few drops of water, and placed over the water-bath. Crystals of oxalic acid are to be added until they are no longer dissolved. It is important to add *excess* of oxalic acid crystals. The mixture is allowed to cool, and the impure crystals of oxalate of urea and excess of oxalic acid are to be slightly washed with ice-cold water, and pressed between folds of bibulous paper, to absorb

* An excellent review of these researches will be found in vol. xlv, p. 156, of the "Medico-Chirurgical Review".

* B will be examined in Lecture III.

the extractive matters. The crystals are to be redissolved in a small quantity of water, placed in a large vessel, and carbonate of lime added until effervescence has entirely ceased. After the mixture has been allowed to stand for some time, it is to be thrown upon a filter.

The solution separated from the oxalate of lime consists of *urea*, with a little colouring matter. It is to be carefully evaporated to dryness, and weighed. If the residue is not entirely soluble in alcohol, it contains impurity which must be deducted from the weight of the urea.

Or, the alcohol extract, C, may be treated with a few drops of water, so as to form a thick syrup; and nitric acid added by drops, while the basin which contains the extract is plunged in a freezing mixture. When sufficient nitric acid has been added to combine with all the urea present, the whole is to be allowed to stand for some time; the crystals carefully washed with a very little ice-cold water, and carefully placed on a porous tile, which will absorb the excess of nitric acid the extractive matters, leaving crystals of *nitrate of urea*, which are to be carefully dried and weighed. By a simple calculation, the quantity of urea is easily ascertained.

D. The residue insoluble in alcohol is to be treated with boiling water, and thrown upon a filter. There remain upon the filter, *mucus* from the bladder and other parts of the urinary mucous membrane; *uric acid; phosphate of lime;* and *ammoniaco-magnesian phosphate*, with a mere trace of *silica*. This residue is to be carefully dried and weighed. It is then to be incinerated; and, after the ash has been completely decarbonised, its weight is to be deducted from that of the residue insoluble in alcohol; and thus the proportion of uric acid and vesical mucus is ascertained. By deducting the united weight of all these different substances—urea, uric acid, mucus, and earthy phosphate—from the solid matter, we calculate the quantity of extractive matter present. According to this plan, we have ascertained the proportion of the following constituents in 500 or 1,000 grains of urine.

Water ....
Solid matter ....
  Urea ....
  Extractive matters ....
  Mucus and uric acid ....
  Earthy phosphate and silica ....
  Fixed salts ....

Many of the processes above described are imperfect, and likely to give results which are not quite accurate; still the plan is one which is practically useful, and, when a series of results is required, answers very well. In the analysis of animal fluids, it is impossible to attain to perfect accuracy, owing to the changes taking place in the ingredients of the fluid, which are produced by the analytical processes to which they are subjected. Moreover, in such inquiries, it is far more desirable to know the general change which takes place, under various circumstances, in the quantities of the different constituents, than to be acquainted with the exact absolute proportion of each present. In a future lecture, I shall allude to the *volumetric analysis* of healthy urine, which can be more quickly performed, but, at the same time, does not yield perfectly accurate results. (See also *Archives of Medicine*, No. I, p. 34.)

Periscope.

EPIDEMIOLOGY, HYGIENICS, AND STATISTICS.

PRISON DIETARY.

DR. EDWARD SMITH has published in the *Transactions of the Association for the Promotion of Social Science* for 1858, and in the *Dublin Quarterly Journal of Medical Science* for May 1859, some important observations on the diet of the inmates of prisons.

In the English gaols, there is a different dietary for county prisoners and for convicts, the latter being usually much in excess of the former. The government has provided a scheme for county prisoners, but has not compelled the magistrates to adopt it; so that, in one-half of these gaols, there is still no uniform scheme of dietary. The author's attention has been chiefly directed to the government scheme, and he considers it to be based upon wrong principles, and unjust in its details. Increase of food with duration of imprisonment is unnecessary, provided the prisoners are supplied with sufficient food from the commencement. Variation in the quantity of nutriment from day to day (the conditions being unchanged) is absurd; and the allowance of one pint of soup per week, as a distinction between no labour and hard labour, is manifestly ridiculous.

The chief defects in the existing scheme are, the deficiency of food in short, and excess of food in long imprisonments; and the apportionment of one, and that an insufficient, amount of food to all kinds of hard labour. It is upon these two points that Dr. Smith has prosecuted a series of experiments.

In the existing scheme, the amount of food supplied varies through five classes from one pound of bread and four ounces of oatmeal daily for the shortest sentences, to twenty-two ounces of bread and one pound of potatoes daily, four ounces of oatmeal four times and two ounces thrice per week, a pint of cocoa thrice per week, with four ounces of cooked meat without bone four times, and three ounces thrice per week, in the sentences of four months and upwards.

Dr. Smith adopts the dictum of Sir James Graham, in his letter of instructions to the Commissioners, that the dietary shall not be made an instrument of punishment; and proceeds to state what is the true amount of food required under different circumstances. He discards the basis of duration of imprisonment, and adopts that of the degree of labour enforced. He suggests that four classes should be established—1. For all cases without labour; 2. Those with light labour, as in ordinary manufactures and trades; 3. In the heavy manufactures, as weaving wide widths of cocoa-matting, and with the use of the lighter cranks and the shot-drill; and 4. With the full pressure of the crank and the treadwheel labour.

In the first classes, he has found, as the result of eight experiments, that eight ounces of carbon and two hundred grains of nitrogen are lost by the system daily (he has not yet determined the amount of hydrogen consumed); and that, in the other classes, the addition is one-fifth, three-fifths, and four-fifths of that quantity, respectively. From this he has deduced the amount of food which must be supplied to meet this waste; and, taking bread and cheese as offering a good basis for comparison, the quantities required in the four classes are as follows:—

1. In rest, twenty-three ounces of bread and two ounces and a quarter of cheese.
2. With light trades, twenty-seven ounces and a half of bread and three ounces of cheese.
3. With heavy trades and light crank labour, thirty-six ounces and three-quarters of bread and four ounces of cheese.
4. With full treadwheel and crank labour, forty-one ounces and a half of bread and four ounces and a half of cheese.

On this plan, a dietary is provided which meets the wants of each man separately, and which is adapted to every prison, notwithstanding the extraordinary diversity which, in a former paper, printed in the *Transactions of the Association for the Promotion of Social Science*, and in the *Philanthropist*, 1858, he has proved to exist in prison discipline.

Dr. Smith states the proportion which other ordinary articles of food bear to bread and cheese, so as to enable any one to vary the kind of food, and yet retain the due proportion of nutritive elements. This is given in the following table, chiefly compiled from Playfair's data, which shows the proportion of carbon contained in various articles of food, as compared with that in ten parts of bread, the quantity of nitrogen contained in each ounce avoirdupois, and the cost per pound at contract prices.

	Parts of various substances equal in carbon to 10 parts of fresh bread.	Nitrogen in each oz. — Grains.	Cost per lb. Oct. 1858. — s.	d.
Bread		5¾		1 1-12
Wheat flour	8	7¾		1¼
Peas	8	15¾		1½
Rice	8	4⅓		1½
Oatmeal	7½	8¾		1½
Scotch barley	—	—		1⅜
Molasses	—	—		2
Meat (fresh)	10	8¾		4½
Cocoa	5	8¾	1	1½
Potatoe	⅓	1½		¾
Suet or butter	4½	—		
Sugar	7½	—		4½
Indian corn	7½	7¾		
Cheese	8	19½		6