occasionally, on pressing on the gall-bladder when it is occupied by a number of large calculi, the *clinking* of these against each other may be felt and heard.

Vascular murmurs are also sometimes observed in cases of abdominal *tumour*. They are most commonly associated with tumour of the uterus (occurring, according to Spencer Wells and Winckel, in about one-half the cases), more seldom with ovarian tumour; Winckel and Hirschfeld report having detected them in subjects suffering from tumour of the spleen, and Leopold has heard them once in hepatic cancer. Their arterial origin is shown by their being synchronous with the pulse.

Auscultation of the Gravid Uterus.

The aim of auscultation of the gravid uterus is the detection of the sounds of the fœtal heart and the placental murmur.

The *sounds of the fœtal heart*, discovered by Mayor, of Geneva, in 1818, are first appreciable towards the end of the fourth month of pregnancy. At this period they are feeble, but subsequently they gain considerably in volume; they are most often heard on the left side of the mother, from the great frequency of the first cranial presentation, in which the back of the child is turned forwards and to the left. Their presence proves conclusively that the child is alive, their absence that it is dead, auscultation thus furnishing an important indication for the adoption or the avoidance of operative interference with the process of delivery.

The *placental murmur*, discovered by Lejumeau de Kergaradec, in 1822, is a sound which is synchronous with the arterial pulse, but is frequently of slightly longer duration, particularly when the abdomen is somewhat forcibly pressed upon with the hand. It is not of equal intensity at all points on the surface of the womb, being louder sometimes to the right side, sometimes to the left. It is heard in the second half of pregnancy, being at first very faint, but afterwards of greater intensity. It is developed in the dilated uterine arteries, at the part at which they terminate in the uterine veins.

EXAMINATION OF THE EXCRETA.

THE URINE.

The points to be noted in examining the urine are its quantity, colour, reaction, specific gravity, and the occurrence in it of abnormal constituents.

Quantity of the Urine.

This is very variable even in perfect health, and depends chiefly on the amount of fluid taken by the patient and on the greater or less abundance of the excretion of water by the sudoriparous glands of the skin. If the consumption of fluid be moderate and the cutaneous transpiration slight, as in winter, the quantity of urine passed by an adult in the twenty-four hours amounts on the average to about 1,500 ccm.

The urine is *diminished* in quantity in all febrile affections, in the stage of failure of compensation in diseases of the heart, and frequently in the different forms of *nephritis* (though in the latter class of cases it sometimes remains normal in volume); it is, further, reduced in a number of other disorders, and occasionally even in health, from causes of only temporary duration, to be mentioned in detail further on.—The quantity voided in the twenty-four hours may, in extreme cases, sink to one-fourth that passed normally; at times even, as in the stage of collapse in cholera, and now and then also in scarlatina, almost complete anuria may be observed.—The cause of this diminished excretion is either that the quantity of blood in circulation is unusually small or that the blood itself is deficient in water, the pressure within the renal arteries being in both cases reduced to a minimum. When in the later stages of cardiac disorders the compensatory changes in the heart's structure fail to completely overcome the obstacle to circulation, the venous system becomes overloaded, the arteries, and among them those of the kidneys, contain less blood than normally, and the excretion of urine naturally goes on but slowly; the urine is scanty also in other conditions in which the blood is not sufficiently fluid, either from the escape of its watery constituents through the walls of the veins, from increase of the cutaneous transpiration, or frequently as the result of the undue abstraction of water from the system by the very abundant and thin discharge from the bowel in diarrhœa and the allied affections. Diminution in the amount of urine excreted, with whatever form of disease it may be associated, and whether it be only a passing complication or a phenomenon of a more persistent character, may generally be easily accounted for by a careful consideration of the series of causes just enumerated.

The flow of urine is greatly *augmented* in *diabetes* mellitus and diabetes insipidus, the intense thirst from which the patients suffer causing them to drink very freely of water; the amount passed daily may increase to three, four, or even eight times that of a healthy person.

A moderate increase in the quantity of the urine may often be produced by stimulating the kidneys by the employment of diuretics; diuresis also appears when, from any cause, the arterial pressure is raised.

Colour of the Urine.

Normal urine varies in colour from pale yellow to clear amber yellow or yellowish-red, the precise shade being determined by the greater or less abundance of the urinary pigments or by the degree of concentration of the urine. It has been calculated that in a healthy urine of clear amber colour there are eight parts of colouring matter to every thousand of fluid, and in a yellowish-red urine sixteen parts to the thousand (Vogel).

Normal urine contains at least two pigments, possibly more. The best known of these is urobilin, first separated by Jaffe; it resembles the colouring matter of the bile (bilirubin), is allied to hæmatin, and is found in the contents of the intestine and in fæcal masses, which owe to it their brown coloration (Vanlair and Masius, Maly). Hoppe-Seyler affirms, however, that urobilin is not one of the actual constituents of the urine, but that the colour of the excretion is due to only one substance, from which, after it has been precipitated by acetate of lead and again separated from the lead by sulphuric acid and alcohol, urobilin is formed by gradual spontaneous oxidation.—Another pigment, *uroerythrin* (or purpurin) gives to the sediment of uric acid and the urates its yellowish-red or brick-red colour.

The urine becomes *reddish yellow or red* in *all febrile diseases,* chiefly from the increased formation of the red colouring matter but partly also from the scantiness and consequent concentration of the urine in fever. This reddish tint is also observed, of various degrees of intensity, in chronic affections, when the volume of urine excreted diminishes to any very marked extent, particularly in the stage of failure of compensation in cardiac disorders.—The urine may, on the contrary, be abnormally *pale* from absolute deficiency of pigment; this occurs frequently in convalescence from severe acute diseases, in anæmic chlorotic conditions, and as the result chiefly of dilution in both forms of diabetes.

Of the abnormal colouring matters which may be present in the urine the most common are those of the biliary secretion and the blood.

A large proportion of *biliary pigment* (bilirubin) gives to the urine a brownish colour, with an occasional admixture of yellowish green or brownish green; an abundant foam, the yellow or green hue of which is more evident than that of the rest of the urine, forms on its surface when shaken. Strips of linen or blotting-paper dipped in such a urine at once take on a marked yellow coloration.—The most convenient test for biliary pigment is that proposed by Gmelin, in which the extremely delicate reaction of bilirubin on impure nitric acid (that containing nitrous acid) is made use of, the test fluid being prepared by adding to a small quantity of the chemically pure nitric acid a few drops of the fuming acid. The icteric urine is poured slowly, drop by drop, down the inside of the test-tube at the bottom of which lies a little of this impure acid, when at the point at which the fluids meet will appear a series of beautiful rings of colour arranged in the following order: the upper ring is bright grass-green, the next below it blue, the others in succession violet, red, and yellow.

Usually only the green, violet, and red rings are constant and retain their colour for any length of time, the blue and yellow being often indistinguishably mixed up with the other shades. The green ring is the only really characteristic indication of the presence of biliary pigment, as the other colours, especially the reddish-violet tints, appear also in urine containing no bile, on the addition of strong nitric acid, the change, in the latter case, showing that another pigment, indican, is present. The more slowly and carefully the urine is added to the nitric acid in the tube the broader will be the upper green ring; the green coloration is also the more intense the more bilirubin there is in the urine.—On allowing a drop of nitric acid to fall on blotting-paper previously stained with the icteric urine a similar green-coloured ring is obtained.

If the biliary pigment be present only in traces it may be separated and recognised by shaking up a quantity of the urine with chloroform; the latter dissolves out the bilirubin, acquiring in this way a yellowish colour; being specifically heavier than the urine, also, it falls to the bottom of the glass.—Ultzmann has recently stated that in cases in which the other ordinary tests fail, bilirubin may be detected in the urine in the following simple way: 10 ccm. of the suspected urine are mixed with 3—4 ccm. of pure concentrated potash lye (1 : 3 of water), and neutralized and finally acidified by adding to it pure hydrochloric acid; as the fluid becomes acid a beautiful emerald-green coloration is developed.—A very striking green coloration is produced on the addition of a few drops of tincture of iodine to the icteric urine (W. Smith).

Bilirubin is found in the urine in all affections attended by jaundice; it may disappear from the urine, however, while the icterus still persists.—Traces of the biliary acids also usually accompany the biliary pigment in the urine.

Blood communicates to the urine a decided red colour, the depth of which depends on the proportion of the abnormal element present. If the blood has been diffused through the urine for some time, and its colouring matter in this way altered, the urine may be reddish brown, brownish black, or even inky black. The colour presented by the urine, even when the blood-pigment has undergone change, and also when the quantity of blood contained is but small, is usually so characteristic that it is almost impossible to mistake it for any other variety of abnormal coloration (such as that caused by the increase of the normal urinary pigment observed in fever, &c.)

The colouring matter of the blood (oxyhæmoglobin) is always liberated from the corpuscles and dissolved by the fluid basis of the urine; it is only in those instances in which the proportion of blood present is exceedingly large, in which accordingly the process of diffusion between the urine and the blood globules is practically arrested, that the red corpuscles still retain their pigment. When urine containing blood is allowed to stand some time, the corpuscles subside to the bottom of the vessel as a red sediment.—Microscopic examination shows the blood disks either distended and more or less pale in colour, or shrunken

and crumpled and of the irregularly dentate outline which they assume in saline solutions. Some cases are met with, however, in which, notwithstanding that the urine is of a deep *blood red colour, the blood corpuscles are completely wanting*, even in urine freshly passed. This variety of the affection is designated *hæmoglobinuria*. It indicates that the disintegration of the blood globules has taken place within the organism itself, the liberated colouring matter then passing directly into the urine. The causes which bring about this destruction of the corpuscles, and in this way produce temporary or persistent hæmoglobinuria, are still obscure.*

In those cases in which the urine has a reddish blood colour but shows no trace of corpuscles on microscopic examination, the presence of the blood pigment may be readily demonstrated by certain *chemical reactions*, and more clearly still by *spectrum analysis*. Of the various chemical reactions given by the colouring substance of the blood probably the easiest to obtain is that observed on boiling the urine after adding to it a little caustic soda or potash; brownish red coagula are formed, consisting of the precipitated phosphates and hæmatin (Heller). The slightest trace of oxyhæmoglobin in a fluid, even as little as 1 part in 10,000, is recognised in the *spectroscope* by the appearance of two separate absorption-bands between Fraunhofer's lines D and E in the *yellow* and *green* of the spectrum. After urine containing blood has stood for some time the oxyhæmoglobin is gradually transformed into *methæmoglobin;* this is simply one step in the series of changes through which oxyhæmoglobin passes in breaking up into hæmatin and albuminous matters. Such a urine is reddish brown in colour, and shows in the spectrum only *one* absorption-band, between the lines C and D. In those urines also which contain blood but from which the red corpuscles have disappeared the oxyhæmoglobin is converted into methæmoglobin.

The blood which is mixed with the urine may be derived from any part of the urinary tract; at one time it is observed only in

* Hæmoglobinuria has been observed in scurvy, septic fevers, and sulphuric acid poisoning, occasionally as one of the effects of the inhalation of arseniuretted hydrogen (Vogel), and in a case resembling intermittent fever (Secchi). In animals (rabbits) the subcutaneous injection of glycerine is followed by a red sanguineous staining of the urine (Luchsinger), which is caused, as I found, not by the presence of the red corpuscles themselves, but simply by the colouring matter of the blood.

traces, at another the urine seems to consist almost exclusively of a perfectly sanguinolent fluid.

The quantity of blood discharged is by no means a sure guide to the part from which it comes, this being indicated rather by the symptoms and appearances as a whole and by the result of microscopic examination of the urine; thus, the hæmaturia is obviously not due to kidney affection if on repeated examination no casts or epithelial scales from the tubuli uriniferi are found.

Several other urinary pigments have been observed, all of them resulting from the decomposition of certain of the normal constituents of the urine. Of these the most important is *indican*. Indican occurs in small quantities in every urine; in decomposing urine it is often seen as a bluish red glittering appearance or as a blue pellicle floating on the surface. The best method of demonstrating the existence of indican in the urine is that devised by Jaffe: to the urine is added an equal volume of hydrochloric acid, and then a few drops of a strong solution of chloride of lime, when the indican is decomposed, indigo is formed, and the urine takes on a *blue* coloration, which is the deeper the larger the proportion of indican present. If the indican be very abundant, a flocculent precipitate of indigo-blue (uroglaucin) is thrown down. Heller's test for indican,—mixing equal volumes of urine and fuming hydrochloric acid, and heating the mixture over a lamp,—gives a beautiful reddish violet coloration (indigo-red, urrhodin), the intensity of which varies with the amount of indican in the urine so treated; if this be unusually large the indigo is separated by this method also as a blue precipitate.

Increase of the indican takes place very frequently in the most diverse diseased conditions, particularly in *consumptive* affections and all disorders accompanied by much debility (Senator); to this category belong diseases of the stomach and bowels, especially cancer of the stomach, ileus, peritonitis, phthisis, &c. The quantity of urinary indigo may rise in ileus and diffuse peritonitis to 50—100, or even 150 milligrammes per day, the normal amount being only 5—20 milligrammes daily (Jaffe).

Brown or *inky black* pigments sometimes appear in the urine of patients suffering from *melanotic cancer*. When recently voided such urine is generally still free of any brownish discoloration; this is developed only after the urine has for some time been in contact with the air, or on adding to it oxidising substances such as chlorate of potash, chromic acid, nitric acid, &c. It is not yet certain whether this brown or black colouring matter is really of pathological origin or is merely one of the normal urinary pigments present in unduly great quantity; it is most probably the former, however, as it differs from the other familiar colouring substances found in the urine in offering greater resistance to their usual solvents (Ganghofner).

There is still another brown pigment sometimes discovered in the urine, and due to the presence of *catechin*; it is formed only after the urine has stood for a considerable period in contact with the air or when decomposition is beginning, and has hitherto been observed in only a few cases in the human subject (Müller and Ebstein, Rajewsky, Baumann). A urine containing this substance becomes intensely green on adding to it one drop of chloride of iron, and this colour changes to violet on the further addition of ammonia or the bicarbonate of soda.

The urine may also incidentally and temporarily be abnormal in colour after the internal administration of certain medicines; after rhubarb and senna it becomes brownish red (from the formation of chrysophanic acid), almost black after inunction with tar and particularly after the internal use of carbolic acid, and yellow, like the urine in jaundice, after santonin.

Reaction of the Urine.

This is usually *acid;* blue litmus paper dipped in the urine is coloured red, while red litmus paper remains unaffected. The acid reaction is owing chiefly to the *acid phosphate of soda* which the urine contains, though sometimes it may be partly due also to free uric acid and acid urates.

The degree of acidity is even in normal conditions very variable, and is estimated according to the intensity of the reddening of the blue litmus paper. Urine of very acid reaction is often associated with inflammatory febrile diseases, especially with acute articular rheumatism, &c.

The urine becomes *alkaline* after exposure to the air for some days. The occurrence of this change, which has been designated alkaline fermentation, is favoured by a high temperature; it is caused by the decomposition of the urea of the urine and its conversion into carbonate of ammonia, probably under the influence of the fungus-germs and bacteria which are suspended in the air and which drop thence into the urine. Alkaline urine renders red litmus paper blue, has a powerful smell of ammonia, and gives a white vapour of chloride of ammonium on holding over it a glass rod dipped in hydrochloric acid.

Even directly after emission the urine may, in a variety of circumstances, give for a longer or shorter period an alkaline or neutral reaction; in the latter case it does not change the colou of either red or blue litmus paper. The urinary secretion is alkalised by the prolonged internal administration of carbonate of soda or potash (in alkaline mineral waters), or of the alkaline salts of the vegetable acids (in various kinds of fruits), all of which appear in the urine as alkaline carbonates. The reaction of the urine is found also to depend to some extent on the secretion of the acid gastric juice; if the acids needed for digestion be (in animals) neutralized by the exhibition of carbonate of lime or magnesia (Maly), or if they be removed from the stomach by washing (Quincke), the urine speedily becomes neutral or even alkaline. The fact also that the acidity of the gastric juice is expended on the food accounts for the neutral or feebly alkaline reaction of the urine so often noticed for a few hours after a meal. In diseases of the stomach, in which from many causes (as from frequent vomiting) very little of the gastric acid is retained, the urine is not uncommonly distinctly alkaline. It is still more markedly alkaline when loaded with pus,—in catarrh of the bladder, in pyelitis, &c.,—when it may, even when recently voided, have a strong ammoniacal odour; if the quantity of pus be moderate, however, the urine does not usually become alkaline, but much more feebly acid than in health. Alkaline fermentation of the urine may sometimes be set up within the bladder by the introduction of a catheter which has not been previously made scrupulously clean. Urine which is alkaline when passed is invariably opaque and turbid, from precipitation of the phosphates; recent urine, when alkaline, may even contain crystals of ammoniaco-magnesian phosphate, exactly as in the case of a urine which has undergone alkaline fermentation outside the body.

Specific Gravity of the Urine.

The specific gravity of the urine is estimated by means of the aræometer (the urinometer). This instrument is placed in a cylindrical vessel filled with the urine to be examined, in which it should swim freely; it sinks the deeper the lighter the urine, and *vice versâ*. The density is indicated by the number on the graduated scale which, when the instrument comes to a state of rest, is found to be on a level with the upper surface of the fluid. Normally the specific gravity of the urine varies from 1015—1020, that of distilled water being regarded as 1000.

In *disease* the density of the urine may mount to 1040 or sink as low as 1005; in many cases even these limits are considerably overstepped.

The specific gravity of the urine *rises*, to 1025 or even a slightly higher point, in *febrile* diseases. This is the result chiefly of *increase of the excretion of urea*; it seems also to be owing partly, but to only a very limited extent, to increase of the other solid urinary constituents (the urates). Some of the solid elements of the urine may even be diminished in febrile conditions; thus, in inflammatory exudative diseases, especially in *pneumonia*, the *chlorides* may almost or entirely disappear from the urine (Redtenbacher). The degree of dilution of the urine also takes an important place among the factors which determine its specific gravity. If the same weight of solid matters be at one time dissolved in a large volume, and at another in a small volume of water, the density of the fluid in the former case falls, and in the latter case rises. The amount of water in the urine is reduced in fever, and in all those conditions which are followed by dropsy and ascites,—in the stage of failure of compensation in heart diseases, in affections of the liver, &c.; in these disorders therefore the density of the urine is increased, a specific gravity of 1030 being generally reached, but not commonly exceeded. Urines which, from deficiency of water, the absolute quantity of solid constituents being either unaltered or possibly increased, possess a density so high, are invariably dark in colour.

But there is another condition in which, notwithstanding that the watery portion of the secretion is greatly augmented, the density of the urine *rises*, from the presence of *sugar* along with the normal urinary solids. Such a urine is distinguished from those just described by its perfect clearness and its pale yellowish colour. The lowest density of urine containing grape sugar (diabetes mellitus) is about 1030; usually it ranges from 1032—1040, seldom rising above 1040—1050, and only in the very rarest cases reaching 1060—1065 (Seegen). The specific gravity, however, is not exactly proportionate to the amount of sugar present, being influenced also by the other solid constituents of the urine, whose quantity may be simultaneously increased or diminished. The proportion of sugar contained in the urine cannot thus be inferred with absolute certainty from its specific gravity.

The density of the urine is sometimes *lowered* temporarily in perfect health, after a large draught of water, the total quantity of urine secreted being in proportion to the amount of fluid taken; the density may from this cause rapidly fall even to 1005. If, however, the specific gravity sinks, notwithstanding that the urinary secretion is *not* augmented, we have before us a fact of distinctly pathological signification. This is observed in anæmic conditions, and frequently also in nephritis; the lowering of the density is here due principally to diminished separation of urea by the kidneys.—Decrease in the density of the urine occurs also in *diabetes insipidus*, from pathological increase of the watery part of the urine, independently altogether of any alteration in the excretion of urea or of the other solid constituents.—All urines of low specific gravity are pale.

Trapp's formula furnishes a ready method of estimating approximately the solids held in solution in the urine. If the two last figures of the specific gravity be multiplied by 2·3, the product indicates in grammes the amount of solid matters present in 1000 ccm. of the urine; thus, if the density be 1015, 1000 ccm. of such a urine will contain 34·5 grammes of solids.

The solid constituents of the urine consist of about equal parts of *inorganic salts* and *urea*. Of the former, the *chloride of sodium* occupies the first place, being excreted to the extent of 10—15 grm. per day; the *sulphates* amount on the average to 2 grm., the *earthy phosphates* to 1 grm., in the 24 hours, while the *salts of ammonia* are detected only in traces.—Of the *organic urinary solids* the most important is *urea*. It constitutes $2\frac{1}{2}$—3 per cent. of the urinary secretion; the other organic elements are much less abundant, $\frac{1}{2}$—$\frac{1}{3}$ grm. of *kreatinine*, 0·2—1 grm. of *uric acid*, $\frac{1}{3}$—$\frac{1}{2}$ grm. of *hippuric acid*, being discharged in the twenty-four hours. The urinary pigments have already been discussed.—Several other organic substances (xanthine, oxalates, &c.,) occasionally appear in the urine, but only in minute traces.

Abnormal Substances in the Urine.

Albumen. This substance passes from the blood into the urine when the blood pressure within the renal veins is increased, whether from inflammation of the kidneys (which is the commonest of all the causes of albuminuria, and gives rise to the phenomenon in its most fully developed form) or as the result of diseases of the circulatory, and sometimes also of the respiratory apparatus, when they produce engorgement of all the systemic veins, and, among them, of the renal veins; or the albumen is one of the signs of the presence of extravasated blood or of pus, which may be mingled with the urine at any part of the uropoietic system; or, finally, it may proceed from other secretions which may have gained admission to the urine accidentally.

The presence of albumen in urine is demonstrated by precipitation. In urine of acid reaction the albumen is thrown down on heating to the boiling-point, by the addition of nitric acid, &c. To ensure accuracy it is better to employ both methods, heating and the use of nitric acid, in examining for albumen, as the phosphate of lime falls as a white precipitate on simply warming the urine, but is again dissolved on adding a few drops of the acid, when the urine becomes clear; *albumen* which has been precipitated by boiling, on the contrary, is unaffected by the nitric acid, or if the first part of the process has been insufficient to coagulate the whole of it the acid completes the precipitation. On the other hand, neither is the simple addition of nitric acid to the cold urine a test which is absolutely free from fallacy, as it produces a slight degree of turbidity in the presence of urates; this cloud is cleared away, however, if the urine be non-albuminous, on applying heat, as the amorphous urates are in this way at once dissolved. When the precipitate is abundant it is always easy to decide, even by simple inspection, whether it consists of albumen, phosphates, or urates: coagulated albumen takes the form of a white flocculent precipitate, the phosphates have the appearance of a more uniform white sediment, while the urates are readily recognisable by their yellowish-red colour.

As albumen is thrown down by heat in acid urine only, and not, or only in small quantity as compared with the actual amount present, in urine which is alkaline, the reaction of the urine should always be ascertained before boiling, and if it turn out to be neutral or alkaline it should be acidified with a drop or two of acetic acid.

Albuminous urines are seldom perfectly clear, the cloudiness by which they are pervaded being caused by the various figurate organised elements which such urines generally contain. If the turbidity be considerable, and the urine be but very slightly albuminous, it is desirable to apply the flame of the lamp to only the upper layer of fluid in the test tube, as this renders the