tends down the œsophagus. The walls of the intestines are not infrequently grayish or blackish from mercuric sulphide, the result of putrefactive changes. In a few instances it has been thought that this gray color has been the result of the deposition of very finely divided metallic mercury.

Antidotes.—The only satisfactory antidotes are albumen, such as white of egg, milk, flour and water, etc.; ferrous sulphate with reduced iron or ferrous sulphide; followed immediately by the stomach pump or emetics and purgatives, unless such action has already been induced. Prompt removal of the material from the alimentary canal is imperative, since the insoluble compounds of mercury produced by the action of the antidotes are all more or less rapidly acted upon by the fluids of the body. The administration of too great an amount of albumen is also probably objectionable, as there seems to be good reason for believing that the compound of mercuric chloride with an excess of albumen is more soluble than when the albumen is not in excess. It is better, therefore, to administer only just the amount which it is judged will render the poison insoluble; then remove the precipitate and administer a fresh dose of the antidote. The white of one egg will render about 260 mgm. (gr. iv.) of mercuric chloride inactive. Stomatitis is best treated by frequent gargles or washes of potassium chlorate. In the treatment of chronic poisoning zinc phosphide has given excellent results. Tremor mercurialis can be more or less successfully treated with electricity. There is at present much diversity of opinion as to the value of iodides and of sulphur compounds such as flowers or liver of sulphur, sulphureted hydrogen waters, etc. There are reasons for believing that although good results have, in many cases, followed the use of these disputed remedies, their efficacy has been somewhat overestimated.

All rooms and buildings, etc., in which either metallic mercury or its salts are employed should be exceptionally well ventilated and every possible precaution should be exercised to avoid spilling material on the floors, workbenches, etc. The most scrupulous cleanliness of all workmen should be insisted upon. The floors of the rooms should be free from all fissures and cracks and should slope gradually from all sides toward the centre in order to facilitate cleaning. Meyer has suggested the sprinkling of the floors with dilute ammonia each day after the day's work is done.

Elimination.—Mercury seems to be eliminated from the body through all the secretions, but chiefly by the glands of the stomach and intestines in the fæces, by the kidneys in the urine, by the salivary glands in the saliva, and by the liver in the bile. For the clinical detection of mercury either the urine or the saliva may be employed. In acute cases the greater part of the poison will be ejected in the vomited matter.

Mercury is known to persist in the body for long periods after all ingestion has ceased. The usual period of elimination in acute poisoning by corrosive sublimate is probably about thirty days, but the metal may persist for months. In subacute cases the period of elimination is thought to be about six months; while following chronic poisoning, mercury is slowly eliminated from the body during periods of almost incredible length. Ogier cites a case communicated by Vadja and Pachkis in which mercury could be detected in the urine thirteen years after the cessation of mercurial treatment!

According to Hoffmann, when vapor of metallic mercury is inhaled there is observed the elimination of free metallic mercury in the urine; several other experimenters have observed the same phenomenon.

Mercury seems to possess a marked cumulative action and is localized chiefly in the liver and kidneys, from which organs it disappears only very slowly. It can be detected in the liver, in most cases, after it has disappeared from other organs of the body.

Action on Animals.—Animals poisoned by compounds of mercury exhibit symptoms similar to those described above for man—namely, stomatitis, salivation, catarrh of the stomach and intestines, cough, eczema, apathy, tremor, cachexia, emaciation and death in coma, more rarely in convulsions, in a few hours or in from ten to fourteen days.

Mechanism of the Action of Mercury.—Science has not yet reached a stage where we can formulate a satisfactory theory for the cause of the action of mercury. Lack of space forbids a discussion of the various hypotheses which have been advanced; suffice it to say that none of them is wholly satisfactory. All that is possible is to glance hurriedly and in a very general way at the mechanism of the action.

Owing to the great affinity of mercury for the nitrogen compounds of the tissues, albuminates of mercury or analogous combinations are formed, causing the death of the cells. This layer of destroyed cells is not impermeable but allows deeper and deeper progressive action, due in part to the penetration of a fresh supply of the poison or to the resolution of the mercury in the albuminate first formed. It is probable that the mercury circulates in the blood in the form of what has been called mercuric chloride-albuminate or sodium chloride-mercuric-albuminate, soluble compounds of unknown composition. The result of the circulation of these poisonous compounds is the death of cells, etc., as shown by the progress of the disease in stomatitis, gastritis, enteritis, salivation, and, even in the early stages, in ulceration of the glottis. That these symptoms are not the result of contact but are of secondary action through the blood is proved by the fact that they appear when mercury is applied externally (ointment) or injected subcutaneously and when only the faintest trace of mercury has reached the intestines. In circulating through the liver the mercury produces an abnormal secretion of bile, accompanied, according to some investigators, by the destruction of countless blood corpuscles, the latter being deposited, so to speak, in this organ, and giving rise to its fatty infiltration, and to anæmia and cachexia. An analogous action takes place in the kidneys where the changes produced in the tubuli give rise to albuminuria. In a short time after circulating through the body mercury causes more or less marked paralysis of the muscles and of the heart; this Rabuteau believes to be due to the destruction of the contractility of the muscles without any action on the motor nerves. According to this view the cardiac paralysis observed soon after the administration of a very large dose is due to the loss of contractile power of the cardiac muscles and is not the direct result of neural paralysis. The experiments of von Mering have shown that mercury exerts a decided and very deleterious action on the vaso-motor system and on the heart. In prolonged illness there can be no doubt that mercury exerts a specific action upon the central nervous system; since we observe erethismus mercurialis and a weakening of the intelligence, perhaps the tremor can be ascribed in part to this action. One of the most remarkable of the effects of mercury is that of the dissolving of calcium salts in the bones, to which reference has already been made; the lime thus extracted is eventually deposited, in part at least, in the kidneys, apparently as the carbonate, clogging the canals (see von Weichselbaum, *Centralbl. f. Path.*, 1891, 1). How and why this action is brought about is unknown.

Kaufmann believes death to be the result of primary intravital multiple capillary embolism in the kidneys and that this is shown in epithelial necrosis, calcification, and capillary thrombosis. Jolles, on the other hand, believes death to be the result of capillary embolism, not in the kidneys but in the intestines.

Clinical Tests for Mercury.—The urine and the saliva are the most satisfactory materials upon which to work. In case the urine is employed it is best to concentrate it to about half its volume. Acidify the solution to be tested with pure hydrochloric acid. Introduce two or three tiny strips of pure bright copper foil about 1 mm. wide by 3 or 4 mm. long. Heat almost to boiling for from ten to fifteen minutes. Pour off the liquid from the foil and wash the latter first with water, then with alcohol, and dry by pressing gently between sheets of filter paper. If mercury is present the copper foil will be coated with a gray or silvery film. A gray film gently rubbed with the end of a finger becomes bright and silvery. The mere deposition of a film upon the copper should not be taken as conclusive evidence of the presence of mercury. In order to confirm the presence of this element the perfectly dry foil can be introduced into a small glass tube closed at one end. The tube should then be heated at a point from about 3 to 5 cm. above the roll of copper foil and drawn out to a bore of say 2 mm., care being taken to avoid heating the bit of coated copper. When the tube thus prepared is perfectly cold, the end containing the foil is heated red hot in a Bunsen or alcohol lamp. The mercury amalgamated with the copper is thus vaporized and condenses on the walls of the tube; by progressively heating the tube above the foil all the mercury is driven into the constricted part of the tube and an examination with a microscope or pocket magnifier will disclose many tiny silvery globules of metallic mercury. In case the globules are very minute, rubbing the deposit with a fine iron wire or with a drawn-out glass rod will cause them to unite into globules large enough to be readily detected. Although this reaction is a very delicate one, it can be rendered even more delicate by converting the sublimate of mercury into red mercuric iodide. This is accomplished by proceeding as follows: The closed end of the tube is cut off, a small fragment of iodine introduced, and the end of the tube closed with a tiny cork. Thus prepared the tube is laid in a warm place for half an hour or more. The slow vaporization of the iodine causes the formation of brilliant red mercuric iodide, which is generally easily visible to the naked eye if the tube be held over white paper. Too high a heat will cause the sublimation of much iodine, thus masking the red color of the iodide. In such an event a gentle current of air drawn or blown through the warm tube will remove the iodine. By this iodine method 0.1 mgm. of mercuric chloride can be detected with ease, and with great care the delicacy can be pushed to beyond 0.01 mgm.

Instead of copper foil a little spiral of thin pure gold foil (dental foil) can be wound around a tiny rod of metallic tin or zinc. The electrolytic couple thus obtained is dropped into the acidulated liquid to be tested. No heating is necessary. After several hours the couple is removed, washed, dried, and heated in the manner suggested above. Most of the mercury amalgamates with the gold, but a part is always deposited upon the tin or zinc; hence after carefully unrolling the gold each part of the couple should be tested.

Another method consists in winding a spiral of platinum foil around a common steel sewing needle, introducing this couple into the liquid and proceeding as described above.

A very convenient arrangement when employing a couple is to drop it into a separatory funnel of suitable size, pour in the acidulated liquid, and open the stopcock so that tiny drops fall very slowly. To make doubly sure, the liquid can be poured back and again allowed to come in contact with the couple.

Solid organic matter can be brought into solution by treating with hydrochloric acid and potassium chlorate on the water-bath. The strongly acid solution thus obtained can be partly neutralized with sodium bicarbonate and tested for mercury by any of the above-mentioned methods.

Emile Monnin Chamot.

MESCAL (OR MUSCALE) BUTTONS.—*Anhalonium. Pellote.* The dried tops of several species of *Lophophorus* (*Anhalonium*), especially *L. Williamsii* (Lem.) Coulter and *L. Lewinii* (Henning) Rusby.

These cactuses grow in high, arid mountain localities of Northern Mexico, and probably also in the adjacent portions of the United States. The stem is mostly subterranean, its upper portion projecting slightly above the surface as a flat disc, roughened with triangular, thick, short, fleshy lobules and bearing in the centre a mass of bristly whitish hairs, in which the small pink flowers are partly concealed. These tops are sliced off and dried, which causes them to shrink to button-shaped discs, one or two inches broad and from an eighth to a quarter of an inch thick. These dics constitute the commercial drug. They are wrinkled underneath and bear above the dried fleshy lobules and the central mass of hairs. In this condition, the withered flowers are scarcely discernible, except after soaking. In the first-named species the hairy tufts are somewhat separated, while in the second they are matted together and less white. The first-named species contains nearly one-half per cent. of the alkaloid *pellotine* ($C_{13}H_{19}NO_3$). The second contains a smaller total of the four alkaloids, *anhalonine* ($C_{12}H_{15}NO_3$), *mescaline* ($C_{11}H_{17}NO_3$), *anhalonidine* ($C_{12}H_{15}NO_3$), and *lophophorine* ($C_{13}H_{15}NO_3$). The Mexican aborigines use this substance as a powerfully narcotic intoxicant, the effects apparently much resembling those from the use of Indian hemp. Ceremonial assemblies are held, at which each participant chews one or more of the "buttons," passing at length into a trance-like state, productive of strange intellectual experiences. Occasionally, when an unusual amount is ingested, the subject does not recover, death resulting.

Nixon found all the alkaloids of *L. Lewenii* to act similarly, being non-irritant, sialagogue, constipating in small doses, apt to be purgative in large ones, which were apt also to cause nausea and vomiting, these results occurring from either gastric or hypodermic administration. Small doses greatly strengthen and, for a time only, accelerate the heart's action, and increase arterial pressure; toxic doses paralyze the vagal endings and later the nerve cells. They also produce a rapid and shallow breathing, death, when it results, being due to respiratory failure. There is a primary stage of exhilaration and talkativeness, followed by complete intoxication. The pupils are now dilated, there is increased reflex activity, but with blunting of cutaneous sensitiveness, and there are auditory and nasal hyperæsthesia, inco-ordination and trembling, hallucinations, especially of vision, with kaleidoscopic play of colors and a rapid flow of ideas, without control. Intellection and introspection appear normal, but dual existence is sometimes imagined. Lewin found the toxic symptoms in rabbits to be similar to those from strychnine. Cushney regards the mescaline as the exhilarating constituent, pellotine as the hypnotic. The medicinal uses of anhalonium have been but little developed. Beneficial effects have been secured from its administration as a cardiac and respiratory stimulant in asthma, from two to five minims of the fluid extract being administered. Anhalonine and pellotine have also been administered for the same purpose, in doses rather smaller than those of strychnine.

Henry H. Rusby.

MESENCHYMA is a term introduced by the brothers Hertwig to designate the non-epithelial portions of the mesoderm. The mesenchyma develops into a great variety of important tissues, so that a knowledge of the histogenesis of the mesenchymal derivatives is indispensable for the pathologist. From the mesenchyma of the embryo arise the connective tissues, the supporting tissue (cartilage and bone), the lymphoid tissue, Wharton's jelly, blood-vessels, blood, lymph vessels and glands, wandering cells, fat cells, pigment cells, marrow, and smooth muscle fibres. The embryonic mesenchyma consists of more or less widely separated cells connected by intercellular bridges of protoplasm and embedded in a highly transparent homogeneous matrix; it is always covered by epithelium, which may be either ectodermal, mesothelial, or entodermal, according to the location of the tissue. See *Embryos* and *Germ Layers*.

Charles S. Minot.

MESENTERY. See *Abdomen*.

MESODERM is the middle layer of the body of the embryo (see *Fœtus* and *Germ Layers*). Mesoblast is also used as a synonymous term; sometimes, however, the term mesoblasts is applied to the large cells in the segmenting ova of certain lower animals, from which the mesoderm proper is produced. A few writers have sought to alter the application of the term mesoderm, but it is almost universally used as above described, and to use it otherwise would now cause unnecessary confusion.

C. S. Minot.

MESOTHELIUM is a term introduced by Minot to designate the epithelial portions of the mesoderm, which line the body cavity; *cf. Cœlom*, including the myotomes (*protovertebræ, auct.*).

METABOLISM.—Incessant chemical change is a characteristic of living substance. It matters not whether we are dealing with an individual cell or with the complicated groups of cells which make up the higher organisms,—in any case activity is associated with a transformation of the complex molecules which build up or are associated with the protoplasm. The expression *metabolism*—or *Stoffwechsel* of the Germans—is used to include the sum total of the chemical exchanges which take place in living organisms. In this broad sense it embraces the transformations which unorganized materials introduced into the body undergo, as well as the chemical processes connected with the various tissues and organs themselves.

The active cells and the living body are not in a state of continued stable equilibrium. Processes of growth and repair occur side by side with the disruption of elementary tissue substance. The term *anabolism* (assimilation) refers to the integrative or constructive changes by which either living protoplasm or new compounds are built up out of simpler materials; while by *katabolism* (dissimilation, disintegration) is meant the series of processes which result in the breaking down of the fixed constituents of the organism. Thus analysis and synthesis may play their part coincidently or successively in the various phases of the activity of the living substance; and when the effects of destructive or katabolic change are no longer offset by appropriate anabolic processes, the functions may become impaired or may cease altogether. Indeed, the continuity of life has been said to depend upon perfect metabolism.

The general features of metabolism may be illustrated by reference to the higher animals. Incidental to the liberation of energy in their bodies, waste products are formed and eliminated by way of the lungs, kidneys, skin, and intestine. Excretion is thus, broadly speaking, a feature of katabolism, the details of which are discussed in other parts of this HANDBOOK. The losses which the body undergoes in the expired air, urine, perspiration, fæces and otherwise, are repaired by the alimentary processes, digestion, absorption, etc., which are likewise more appropriately considered by themselves (see *Digestion, etc.*). The facts noted serve, however, to emphasize the importance which the study of nutrition has for a correct understanding of metabolism in the wide sense in which it is here used. The materials utilized must be replaced; intake of matter succeeds output, and accordingly compounds related to the body constituents—the foodstuffs—are taken up by the animal and prepared for assimilation. By *nutrition* the losses of the body are made good and a normal condition of life and growth is maintained.

It will thus be seen that metabolism, in its entirety, consists of a series of complicated processes. In plants the synthetic changes predominate, and highly complex compounds are built up almost directly from the elements. In animals, on the other hand, katabolism largely prevails. Our acquaintance with synthetic processes in animal organisms has, however, been extended greatly in recent years; so that the physiologist of to-day is inclined to point out differences quantitative rather than qualitative in kind, between the life of plants and that of animals.

The chemical changes which the living substance or included materials (food, drugs, etc.) most commonly undergo in the metabolism of the animal body are: cleavage and oxidation. The foodstuffs, for example, entering the organism in the form of complex molecules of carbohydrate, fat, and proteid, undergo a more or less complete combustion. Oxygen unites with carbon to form carbon dioxide and with hydrogen to form water; the nitrogen of the highly complex proteid substances reappears in combination with carbon, hydrogen, and oxygen as urea, uric acid, hippuric acid, etc.; the sulphur and phosphorus of organic compounds are eliminated after oxidation to sulphuric acid and phosphoric acid. The final conversion of the ingesta is, then, on the whole, an oxidative process, although synthetic and reduction processes may occur at various intermediate stages. It is through the katabolic processes just described that the potential energy of the foodstuffs is ultimately transformed to maintain the temperature of the body and accomplish its work. In the cleavage of complex compounds to simpler ones part of the potential energy of the ingested food, perhaps stored up temporarily in the form of glycogen or tissue fat, becomes kinetic. In some cases the combustion proceeds to the same end-products which arise by oxidation outside of the body; or, again, the compounds which are discharged by the elimination of the products of katabolic changes may be incompletely oxidized or even undergo subsequent synthesis, as is true of such substances as urea and hippuric acid. The burning up of coal in the steam-engine involves a relatively simple and distinct process. Quite different are the comparable changes in living organisms. Here the materials which serve as the source of energy are liable to undergo a whole series of transformations of distinct and varying chemical character. In some cases, for example, the materials are to be utilized in the liberation of heat, while in others they may become in part adapted to renew the structure of the tissue,—to replace the worn-out parts of the machine, as it were. However obscure the knowledge of the intermediate processes here involved may be at present, it is certain that animal heat, protoplasmic movement, muscular contractions, and electrical phenomena are all referable in origin to the metabolic processes mentioned above.

It was formerly believed that the bulk of the oxidative changes in the animal body takes place in the blood and tissue fluids. The promulgation of the cellular theory in biology gave a new trend to observations on the animal functions. While admitting that oxidation may occur to some extent in the circulating medium, the physiologist is inclined to-day to look upon the tissues as the chief seat of the metabolic changes. The component cells, rather than the tissue fluids, are the laboratories in which the specific chemical reactions are carried out; and thus it is possible to understand how processes of widely differing character—hydration and dehydration, oxidation and reduction—may proceed simultaneously, yet independently, in the complicated structure of the protoplasm. Numerous experiments speak against the importance of the blood for the physiological oxidations which take place in animals. Thus in frogs and rabbits only slight alterations in these processes have been observed after removal of large portions of the circulating medium. Easily oxidizable substances like lactic acid, which are scarcely affected by direct contact with blood, are readily transformed when surviving organs are perfused with blood containing them. A good illustration of this is obtained by passing blood in which uric acid is dissolved through the isolated liver of mammals. The uric acid is decomposed through the agency of the living cells. With blood alone little change occurs; it is merely the intermediator by which oxygen is conveyed to the active tissue. In general, then, the changes which the blood itself undergoes in its transit along the vascular channels form only an insignificant part of the total metabolic transformations which go on.

It may be well to point out here a further peculiarity of animal oxidation. The reaction with the respired oxygen is by no means a direct one. The products of metabolic activity in the organism indicate clearly that the chemical changes are not dependent on a natural affinity between the oxygen and the organic compounds of the body. The combustions in the organism in many

cases proceed at a temperature at which no reaction can be brought about with oxygen outside of the body. It is only necessary to recall the readiness with which fats are completely burned up in animals, whereas in the laboratory such compounds are not easily oxidized at low temperatures. In other cases a selective utilization is shown. Such differences between the oxidations within and without the body emphasize the peculiar importance of the structural integrity—the cellular organization—of animals for these metabolic processes. The agencies by which the cells bring about these changes are as yet little understood. It seems probable, however, that the so-called unorganized ferments, or enzymes, are likely to assume an increasing prominence in the future study of the work of cells. Indeed, typical oxidative enzymes (oxidases) have already been found in many of the tissues.

The study of metabolism has for its object the investigation of the exchanges of material by which vital phenomena are produced, and the "conversion of chemical tension into living energy." The various processes concerned are by no means the same in all organs and tissues. The functions of the liver and of the salivary glands, for example, are distinct in many ways. Valuable data may be obtained by observation of the changes in isolated parts of the body. By maintaining an artificial circulation through "surviving" organs severed entirely or in part from their normal relations, the life of the cells may be continued for hours. Chemical analysis of the tissues under these circumstances may throw light on their metabolic processes; and changes in the composition of the circulating medium are likely to reveal the nutritive demands, the waste, or the specific elaborations of the cells. Again, by exclusion of individual organs their normal activity may be inferred from the absence of certain functions. The work of the spleen, the kidneys, the thyroids, has thus been elucidated by observations on individuals entirely or in part deprived of these organs. Finally, the changes in metabolism which accompany diverse pathological conditions of the body have also contributed to our knowledge of the subject. It is obvious that many difficulties attend the investigation of the metabolism of individual organs, although the problems involved are of great importance in physiology. Most of our knowledge of metabolism has come from a study of the organism as a whole. The intake (food and oxygen) and the output (excretions) have been ascertained under the most varied conditions, while the understanding of the intermediate processes is still largely a matter of "gaps and guesses." The body is constantly undergoing losses which must be made good sooner or later. New material must be contributed to replace the supply which has been exhausted. Some losses may be temporary, as in the secretion of milk, the production of eggs, the ejection of semen or menstrual flow. All of these are, however, relatively insignificant. Body substance is constantly being eliminated in other ways. The lungs give off carbon dioxide and water; through the kidneys, water, inorganic salts, and the nitrogenous compounds (urea, uric acid, hippuric acid, creatinin, etc.) of the urine are carried away; the skin eliminates water and inorganic salts together with insignificant traces of nitrogenous compounds (urea), epidermis formations, sebum, etc.; and with the fæces there passes out a mixture for the most part composed of residues of the digestive secretions, waste from the lining of the alimentary canal, indigestible materials, and (to a small extent only under normal conditions) undigested food residues. The following table compiled by Hammarsten indicates the average range of the quantities excreted in twenty-four hours by adult men living on a mixed diet.

TABLE A.

Water	2,500	to	3,500 gm.
Salts (with the urine)	20	"	30 "
Carbon dioxide	750	"	900 "
Urea	20	"	40 "
Other nitrogenous urinary constituents	2	"	5 "
Solids in the excrements	30	"	50 "

The relative importance of the various excretory channels may vary greatly according to external circumstances. Hammarsten has divided the loss in the following way: by the lungs, 32 per cent.; by the kidneys, 46–47 per cent.; by the skin, 17 per cent.; by the fæces, 5–9 per cent.

With the nature of the excreta and the channels by which they leave the body once established, it becomes possible to collect the output and quantitatively determine the component elements in order to compare them with the materials ingested. The make-up of various dietaries has been discussed elsewhere (see *Food*). The proteids, carbohydrates, and fats which are the main constituents contain the elements C, H, N, O, S, and P; other elements—Cl, Na, K, Mg, Ca, Si, F, Fe, I—occurring in very small amounts or merest traces only. The day of twenty-four hours is ordinarily taken as the unit period in experiments on metabolism in which the *balance of nutrition*—the relation between output and intake—is determined. The food and the solid and liquid excreta are readily analyzed by well-known chemical methods. For estimating the gaseous products—viz., the carbon dioxide and watery vapor given off and the oxygen consumed—special forms of apparatus have been devised. Respiration apparatuses for this purpose have been perfected by Regnault and Reiset, Pettenkofer and Voit and the Munich School, Hoppe-Seyler, Zuntz, Sondén and Tigerstedt, and Atwater and Rosa. For the details of construction of the various forms devised, the works referred to at the end of this article may be consulted. In general, the individual (man or animal) is confined within a large box or respiration chamber, through which a measured volume of air is constantly being passed. Portions of the air entering and leaving the chamber are analyzed, the CO_2 and the H_2O in particular being determined. The gain of these compounds in the air leaving the apparatus is directly attributable to the gases expired. The oxygen consumption is ordinarily ascertained by calculation, although in certain types of apparatus it can be estimated directly. In Zuntz's form the expired gases are collected directly from the mouth, respiration proceeding through an appropriate two-way valve while the nostrils are kept closed. Experiments of the latter sort can be carried on for short intervals only. On the other hand, the portability of the apparatus has made it possible to make observations under the most diverse conditions, such as mountain climbing, marching, bicycling, swimming, etc.

After this brief review of the methods ordinarily employed in the study of the total metabolism of the body, attention may be directed to the statistics of nutrition derived therefrom. It has been assumed by investigators that no essential differences exist in the main features of metabolism in the higher vertebrates; and many of the data obtained from observations on animals have been applied to man. So far as is known the chief end-products formed in the exchange of materials in all of these individuals are practically alike, carbon dioxide, water, and urea being of predominant importance. It by no means follows, however, that the details of the processes are the same in the different species. That the body cannot continue to undergo losses through the various excretory channels already described, without experiencing marked changes in its composition, is evident. The relationship between the incomings and outgoings—the *balance of matter*—may vary in different directions, a gain or loss resulting as the case may be. With a perfect balance maintained—*i.e.*, where no gain or loss in the weight of the animal body occurs—*nutritive equilibrium* is said to result. A determination of the balance of nitrogen and carbon permits the more important deductions regarding the metabolism of matter to be made. The following illustration (Table B) of the establishment of complete carbon and nitrogen equilibrium in a man of 70 kgm. living on a mixed diet is adapted from Ranke.

It is interesting to note how perfectly this nutritive equilibrium may be maintained for considerable periods