CHAPTER X

VITAMINS, HORMONES AND ANÆSTHETICS

EMPHASIS has been laid in the foregoing chapters on the body-building foods and the part played by carbohydrates and fats in supplying the requisite energy to keep the body in the state of health and activity. It has been found, however, that if the various articles of diet, proteins, fats, etc., were all chemically pure, the growth, in the case of the young, and the standards of health would not be all that might reasonably be expected. Although the calorific values of fats obtained from different sources may be approximately the same, it happens that the nutritive values may differ very considerably. This is contrary to the principles already laid down. We have seen that fats and vegetable, animal and fish oils are compounds of glycerine and fatty acids, and can be resolved into their constituents by boiling with alkali, a process which the chemist calls " saponification." If these oils and fats were chemically pure, then they should be entirely disrupted by such a treatment. As a rule, the natural oils and fats do not undergo complete decomposition in this manner. There is always a small proportion which does not yield to such drastic treatment. In assessing the value of these fats and oils the analytical chemist regarded this " unsaponifiable matter " as an impurity. Judged from the chemist's standard of purity this unsaponifiable matter was certainly not "fat" and it therefore was an impurity. Thanks to the pioneer work of Sir W. Gowland Hopkins, of Cambridge, dating from 1906, it is now known that this "impurity" often contains just that substance and usually in the minutest amount, which enables the animal body to utilise the fat to its fullest advantage. Without it, the food may be of little or even no avail. Until 1912, when Hopkins published his important experiments on the feeding of rats, it was believed that all fats possessed the same food or nutritional value. To-day, these small amounts of impurity are known to be of paramount importance, for it is in these "unsaponifiable fractions" that the fat-soluble vitamins are concentrated. Not all vitamins, however, are found in fats and oils.

These accessory food-factors were first believed by Funk to belong to the class of nitrogenous bodies, known as amines, and were consequently given the generic name of "vitamines." Although no vitamins have yet been isolated, sufficient is known of their probable constitution to state that, with the possible exception of vitamin B, they do not belong to the class of "amines." The original name, "vitamines," is yet another example of mistaken nomenclature. Instead of introducing a more suitable name, the original term has been retained, with the exception that the terminal *e* is deleted. It is a remarkable fact that, although these vitamins are absolutely essential to the life of animals, animals and human beings appear to be quite unable to manufacture them within their bodies. Their synthesis seems to be an exclusive property of life in the vegetable kingdom. They are found in various parts of the animal body, e.g., the liver of fish, but they originally must have been derived from some vegetable source. Vitamins, in the very small quantities that are actually required, must be taken in one's food. This condition is usually satisfied, especially if sufficient food is taken of vegetable origin and of which the vitaminic activity has not been destroyed in the process of cooking. Danger creeps in those foods that have undergone drastic chemical treatment, and this is especially true of margarine, for in preparing oils for margarine manufacture they have to be boiled and often subjected to hydrogenation. It is gratifying that methods have recently be devised by which the deficient vitamins in this synthetic food can be restored. Food manufacturers have readily reacted to the recent discoveries in connexion with vitamins and have placed on the market various types of food, the vitamin contents of which are claimed to be high. It should, however, be remembered that the requirements of a single person is low, and, moreover, it has not yet been ascertained what actually are the optimum requirements, though it has been definitely proved that very large quantities of vitamin D may cause a condition of *hypervitaminosis*, in which calcification may occur in undesired places. Undoubtedly many reliable concentrated vitamin preparations are now procurable, but care should be experienced in their use, though except in the case of diseases caused by vitamin-deficiency it is certainly much better to rely on a wholesome balanced diet for one's need of vitamins.

As the result of the classical experiments of Hopkins, 1906–12, the presence of two accessory food factors or vitamins, one, the fat-soluble vitamin A and the other, the water-soluble vitamin B, were gradually revealed. A little later, it was found that the juice of lemons and oranges contained another vitamin, now referred to as vitamin C, which was able to cure patients suffering from scurvy, a disease which had long been recognised as a deficiency disease brought about by abstaining from fresh vegetables. In 1924 it was suspected that another factor existed in certain oils and fats which was useful in the prevention and cure of rickets, a disease in which the bones of children were improperly formed and hardened. This antirachitic vitamin is vitamin D. Although this vitamin has not yet, with certainty, been prepared in the pure state, there is adequate evidence to show that it can be produced by allowing ultra-violet radiations of suitable wave-length fall on certain chemical compounds, which, incidentally, exist under the skin and may therefore explain some of the beneficial effects of ultra-violet ray treatment. Reference will again be made to this subject. What was originally considered as the single vitamin B is now known to be at least two, B_1 and B_2, though a little evidence has recently been advanced that it contains two others, B_3 and B_4. Yet another vitamin, E, has been traced. Its existence was proved by Evans in America in 1922. It is instrumental in preventing sterility in animals. The table on page 142 summarises the distribution of these vitamins in nature and gives their chief functions.

Vitamin A

The table shows that vitamin A serves to promote growth, helps to maintain the defences of the animal

Vitamin	Where Found	Use
A	Liver fats from certain herbivorous animals. Milk, butter, cream. Fish liver oils. Many green vegetables, *but* not in vegetable oils	(1) Growth-promoting (2) Anti-infective (3) Prevents xerophthalmia
B_1	Yeast, seed germs, egg yolk, nuts, many green vegetables	(1) Prevents polyneuritis in birds (2) Prevents beri-beri in man
B_2	"	(1) Growth-promoting (2) Prevents pellagra
B_3	"	Health of pigeons
B_4	"	Growth of rats
C	Most fresh fruits and vegetables	Prevents scurvy
D	Milk, butter, cream. Fish liver oils	Prevents rickets
E	Wheat-germ oil. Certain green vegetables, e.g. lettuce, peas. Not in cod liver oil	Prevents sterility

organism against infection and prevents the eyes from being attacked by the eye-disease, known as xerophthalmia. It is synthesised only by plants where oddly enough little or no oil is found. Indeed, it is not found at all in vegetable oils. Animals and fishes eat these plants, in whose bodies the vitamin becomes associated with the various oils which are stored up within the livers and which are also secreted in milk. The liver oils of herbivorous animals, e.g., sheep, calves and oxen, usually contain about ten times the concentration of vitamin A of cod liver oil. It used to be thought that cod liver oil was the substance richest in this vitamin, but it has also since been found that the liver oils of salmon and halibut may often be as much as one hundred times as rich. Drummond has shown that marine diatoms can synthesise vitamin A under certain conditions. These plants, however, are not devoured by the cod, though they constitute the food of the smaller animals, which then become the food of larger fish, until finally they are consumed by the cod and other large fish. At present there is no specific chemical test for vitamin A. The chemist has to rely for the recognition of vitamin A on the power of the food or concentrate to restore the growth of young animals the development of which has been inhibited by feeding on a suitably deficient diet. Without knowing the chemical nature of the vitamin it is possible to judge the potency of the food or concentrate in terms of the rate of growth which it is able to promote. Vitamin A is not easily rendered impotent by heating, provided that it is done out of contact with air, preferably in an atmosphere of nitrogen, for it is apt to be destroyed by oxidation. Drummond has investigated the unsaponifiable portions of a number of oils and has been about to state precisely what 95% of them are, but the vitamin A has still escaped discovery. He believes it to be contained in the remaining 5%. It is probable that vitamin A constitutes much less than 1% of the unsaponifiable impurity. It is believed that they may possibly in some way be associated with the pigment, carotene, which has been prepared from carrots, nettles, spinach, wheat, butter, body fats, liver, animal and human serum and even cows' ovaries and gallstones. Much mystery, however, is attached to this baffling problem of the exact nature of vitamin A.

Vitamin B

A nervous disease, beri-beri, to which Asiatics are subject has been traced to their diet being deficient in what is known as vitamin B_1. This trouble owes its origin to the use of polished rice, the accessory food factor which would have provided the necessary protection against this disease being lost in the rice polishings. Ejikman similarly observed that fowls fed on polished rice developed a nervous trouble, so-called polyneuritis, whilst those that received unpolished rice continued to flourish. In both cases the deficiency was of vitamin B_1. This condition can also be produced in pigeons and rats, and there is little doubt that beri-beri and polyneuritis are intimately related. Both begin with a failure in nutrition, which is followed almost immediately by a loss in weight and then by symptoms suggesting a peripheral neuritis.

The characteristic property of the vitamins belonging to the B class is their solubility in water. In marked contrast to vitamin A, they do not seem to be stored up within the animal body, so much so that very soon after the diet has become deficient, failure of growth results. Fortunately these vitamins are widely distributed in the various articles of diet, though they differ with regard to their potency and stability towards heat. It became apparent in 1928 that this was due to the existence of two vitamins, B_1 and B_2, occurring in differing proportions. Vitamin B_1 is easily destroyed by heat and prevents or cures beri-beri in man and polyneuritis in birds. On the other hand, vitamin B_2 is more stable towards heat, is growth-promoting, prevents human pellagra (a disease characterised by digestive trouble, and peculiar skin and mental symptoms, generally ending in insanity), and is a necessary addition to vitamin A in the maintenance of health. As a rule, vitamins B_1 and B_2 occur together, though their relative proportions differ. Thus wheat-embryo is rich in B_1 and poor in B_2, but milk and green leaves are more potent in B_2 than in B_1. Another good source of these vitamins is brewer's yeast. As shown in the table, there is also the possibility of the existence of two other vitamins, styled B_3 and B_4, though it is not yet possible to say anything really definite concerning them. Although the chemical identity of none of the B vitamins has yet been established, it is definitely known that they dissolve in water, and are very readily extracted from vegetables and fruits during the process of boiling with water.

Vitamin C

Vitamin C is the antiscorbutic vitamin. It is soluble in water and its potency is readily destroyed by oxidation, such as may occur on being left exposed to the air. It is present in most fresh fruits, particularly in the juice of the orange, lemon and tomato. Although the lime is closely related to the lemon from a botanical point of view lime-juice is markedly inferior to that of the lemon as regards its content of vitamin C. Raising the temperature is destructive to vitamin C, so also is any treatment involving the use of alkalis. Thus dried or cooked fruits rarely contain any vitamin C, whilst any cooking process in which soda is added is particularly deleterious. The conclusion to be drawn from this is the advisability of including uncooked fresh fruits and salads in one's diet. As is the case with the previous vitamins, vitamin C is yet unknown as far as its actual composition is concerned. Chemical methods are, however, available by which the active material in lemon juice can be extracted and obtained in a concentrated form. Thus Zilva, in 1924, extracted 0·3 gram of vitamin C concentrate from 1 litre of lemon juice that contained 80 grams of solids.

Vitamin D

Vitamin D is the ricket-preventing or antirachitic vitamin. It is a fat-soluble vitamin and is present in the unsaponifiable impurity of cod liver oil. In general, it is associated with vitamin A and until 1921–1922 these two accessory food factors were considered to be one and the same. McCollum, in America, however, was able to show that cod liver oil did actually contain two vitamins, one which could easily be destroyed by oxidation, whereas the other could not be so destroyed. By bubbling air through cod liver-oil at 100° C. for several hours it was found that the oil became of no use in the treatment of xerophthalmia, the property of vitamin A, whilst it was still of service in the treatment of rickets.

The search for the actual substance that has the properties of vitamin D, although it has not yet been crowned with success, is one of the romances of modern science. It brings into prominence the need for chemical methods of extraction and preparation of even greater refinement than have been known hitherto. This has been rendered necessary by the chemist submitting his products to examination by means of sensitive physical instruments. Thus Drummond eliminated the substance, cholesterol, from the unsaponifiable matter of cod liver oil and purified it by more than twenty recrystallisations. This substance was extraordinarily pure but, incidentally, possessed vitamin D potency. Rosenheim and Webster, however, proved that cholesterol, which had been derived from another substance by a strictly chemical method, could not be activated when subjected to ultra-violet light radiations. Spectroscopic examination by Heilbron, in Liverpool University, of Drummond's highly purified product led to the conclusion that its vitaminic activity was not due to the cholesterol itself but to an impurity that constituted less than one-thousandth part of the substance. This substance in which the activity of vitamin D has been found to be concentrated is ergosterol. It is not itself vitamin D, but vitamin D can be produced within it by means of ultra-violet light. For this reason, it is usually called pro-vitamin D. The quantities of ergosterol in cod liver oil are much too small to be capable of extraction as such, though concentrates having high vitamin D potency can easily be obtained. Ergosterol can be prepared from the ergot fungus that grows on rye or from a fungus of yeast. By subjecting the inactive ergosterol to ultra-violet radiations of wave-lengths ranging from 2,600 and 3,000 Ångstrom units (1 Ångstrom unit=0·000,000,000,1 metre) some change occurs within the molecule that makes it the most potent antirachitic agent known. What this change is remains obscure. The vitamin D so formed may be destroyed either by prolonged exposure to the ultra-violet light or by using radiations of wave-length shorter than 2,600 Å.U.

These observations furnish an explanation why exposure to sunlight, which contains some ultra-violet light radiations, and to ultra-violet radiations alone, may have a beneficial effect in curing rickets in the same way as cod liver oil. Though the skin contains no vitamin D, it does contain from 13% to 24% of cholesterol, with which is always associated some little ergosterol, i.e., provitamin D, and which under the influence of ultra-violet light radiations become converted into vitamin D.

Whatever may be the constitution of vitamin D, we know that it is composed only of the elements, carbon, hydrogen and oxygen. The next question arises is: "How can such a substance have any effect on bone-formation, rickets being a condition of faulty bone-formation, in view of the fact that it contains neither lime nor phosphoric oxide from which the bones are actually formed?" It is obvious that in order for vitamin D to have an antirachitic potency it is imperative that sufficient of these bone-forming substances shall be received by the body in the food taken. McCollum and his collaborators have found that the ratio of calcium to phosphorus was of infinitely greater importance in ensuring normal bone formation than the absolute amounts of these two elements actually absorbed in the diet. They found that the function of vitamin D was to correct the improper balance in calcium and phosphorus taken. If the calcium : phosphorus was entirely out of proportion to the requirements for bone-formation, then the reception of larger amounts of antirachitic vitamin became necessary to ensure that normal calcification occurred, though, of course, to a much reduced extent. They claim that, even

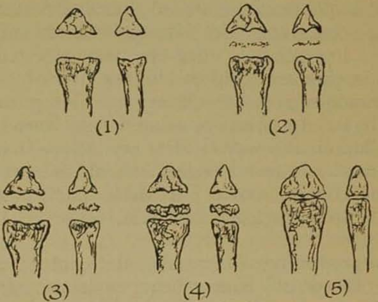


FIG. 22.—Illustrating Steenbock and Black's method of testing the healing effect of vitamin D on the ulnæ and radii (bones in the fore-legs) of rickety rats. The upper portions represent the epiphysis; the gaps, the metaphysis, which in a healthy animal should be narrow; and the lower parts, the ends of the long bones. (1) Illustrates a case of severe rickets, whilst (5) shows the condition in health, and (2–4) represent calcification taking place within the metaphysis as the result of the administration of vitamin D. The diagram refers to some experiments carried out by Dr. Katharine H. Coward in 1928, using Irradiated Ergosterol. Sometimes calcification proceeds directly from the ends of the long bones across the gaps. The seats of recent calcification are detected by the action of silver nitrate solution in being converted into silver phosphate, which on exposure to brilliant sunshine or U.V. light darkens in colour.

when the supply and ratio of calcium to phosphorus are adequate, unless vitamin D be present defective bone formation will occur. The progress of the curative action caused by vitamin D may be followed by means of (1) X-rays of bones and (2) chemical examination of bones at the joints, the animal having been previously killed.

It is well known that one of the grave consequences of the World War was an increased prevalence of infantile rickets, and this was particularly the case in Central Europe, where the fat available for food was very limited. The shortage of fat was created by its use in the manufacture of glycerine required for making explosives. Dr. Hariette Chick found, in Vienna, immediately after the war that cures of rickets in children could be effected either by (*a*) administration of cod liver oil, or (*b*) exposure to ultra-violet light. In 1922, Hess and Unger were able to state that of the ultra-violet rays, those having a wave-length of 3,000 Å or less were the most effective. The penetrative power of these particular rays through ordinary glass and skin, however, is very small.

The possibility of increasing the content of vitamin D of foodstuffs is now being exploited. Perhaps the first clue to this was provided by some experiments of Hume and Smith in 1923, in feeding rats on deficient diets and placing them in vessels containing air which had previously been exposed to ultra-violet light. These rats thrived, but other workers failed to obtain similar results. Later it was ascertained that sawdust had been placed on the bottom of Hume and Smith's glass cages, which incidentally had also been irradiated and which had been eaten by the rats. The curative effect was ultimately traced to the irradiated sawdust, which thereby had acquired anti-rachitic activity. In 1924, Steenbock and Black showed that antirachitic properties could be conferred on those foodstuffs that contained some cholesterol, and therefore ergosterol, even though they had previously no such property. Irradiated milk is becoming an article of commerce, though care should be exercised in its administration. It should preferably be mixed with suitable amounts of ordinary milk, e.g., 2 parts of the latter to 1 of the former. It has been stated to be especially effective in the treatment of rickets, certain bone diseases and certain forms of tuberculosis, and of disorders associated with pregnancy and lactation.

Treatment with ultra-violet rays has been accorded to lactating cows and goats. It happens that during the period of lactation the animal is generally losing from her body in the milk more calcium and phosphorus than she is able to ingest, with the consequent drain on her normal store and ultimately on her skeleton. Irradiation has been claimed to be of value in assisting a suitable calcium-phosphorus balance to be maintained. Ultra-violet radiations have been useful in treating leg weakness in young chickens, and in enabling hens to give increased production of eggs that are richer in their content of calcium in both the shell and egg itself. Artificial irradiation during winter of animals and poultry may probably be advantageous.

A word will not be out of place here on ultra-violet ray treatment. On account of the fact that irradiation produces vitamin D in the body, this type of treatment has become fashionable and manufacturers of suitable apparatus have availed themselves of the situation. Besides producing vitamin D light can cause an increase in the power of blood corpuscles to dispose of any invading bacteria. Unfortunately this increased bactericidal power soon disappears and may even leave the blood in a condition below normal. Regarding the production of vitamin D by exposure to artificial ultra-violet light, the Medical Research Council is of the opinion that "there is no reason at all to suppose that the treatment of rickets, or the supply of vitamin D to the body for any other purpose can be better effected by ultra-violet rays falling on the skin than by the provision of the necessary food values. . . . The use of artificial light to supply only what the right food can give is merely wasteful. It commonly costs three or four shillings to give by light an effective supply of vitamin D that would cost less than a penny if given by the mouth in the form of cod liver oil or otherwise." Ultra-violet light treatment is, however, of value in some cases, e.g., when patients cannot tolerate vitamin-containing substances, or when the absorption of fat is faulty.

Manufacture of Margarine

Efforts have been made recently to add suitable quantities of vitamins A and D to margarine. A method introduced by Planters Foods, Ltd., consists of dissolving vitamin concentrates, obtained from marine liver oils, in a high-class edible oil to be used in margarine manufacture. Margarine is made from refined oils and fats, including hydrogenated oils, such as ground-nut, soya bean, etc. The chief constituents are: premier jus, a product of the fats of the caul and kidney of oxen and cows; oleo-oil and oleo-stearine, being the lower and higher melting fractions of premier jus; lard, lard oils, and, in addition to hydrogenated oils, such vegetable oils as palm kernel, coconut, arachis, palm, cotton-seed. They are melted to a homogeneous mixture and the molten fat is run into tanks, where it is emulsified with milk, from which the cream has been separated, and has also been pasteurised and inoculated with lactose-fermenting bacteria until "ripe" enough to impart to the margarine a butter-like flavour. The mixed oils, emulsified with the ripened milk, are sprayed on to the juncture of two closely-rotating drums which are cooled internally with chilled brine. The solid margarine is removed as films from the rollers, and, after tempering and maturing has been effected, the films are kneaded and finally blended with the addition of salt. It is then ready for use.

Vitamin E

Vitamin E plays an important part in the reproductive cycle, without which, it is stated by Evans, normal reproduction cannot occur. The female organism appears to be quite incapable of synthesing this vitamin, though it is able in the reproductive glands to produce the requisite hormones involved in the act of reproduction. The vitamin is found in the non-saponifiable matter of wheat-germ oil, though curiously enough not in cod liver oil. This is surprising in view of its stability, it being more stable than either vitamin A or D. Hitherto, this vitamin has received very little investigation owing to the considerable difficulties that are involved.

HORMONES

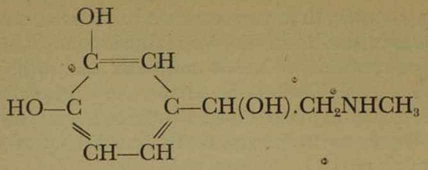
Recent work has shown that small amounts of chemical individuals are necessary in the body in addition to vitamins to maintain it in a healthy state. Unlike vitamins these essential substances are manufactured in the body itself and do not depend on their possible reception from the various articles of diet. These substances are synthesised in the ductless glands. They are known as hormones or " chemical messengers, for whenever a particular organ requires stimulation these hormones are liberated into the blood-stream only to be received at an infinitesimally short time afterwards by the organ in need. This rapid transmission in the blood is rendered possible by the action of the heart, for it sends normally 3 gallons of blood from the right side of the body to the left in every minute. During violent muscular activity this quantity may become as high as 10 gallons. With the exception of thyroxine, the hormone secreted by the thyroid gland, and of adrenaline, a hormone sent out by the supra-renal glands situated just above the kidneys, the chemical constitution of the various hormones has not yet been definitely established.

INSULIN.

This substance, which finds its way into the blood, exercises a regulating action of its glucose content (see page 121). In health, the necessary amount of insulin is provided by the pancreas, but in recent years, thanks to Banting, of the University of Toronto, it has been found that in cases of diabetes, in which the pancreas are unable to supply either enough or any insulin, it is possible to introduce into the blood-stream, by injection, doses of insulin that have been extracted from the islet tissue of the pancreas of dead animals, e.g., ox, sheep, pig, fish. The isolation of the insulin must be carried out at a low temperature to avoid its being destroyed by the action of trypsin, also found in the pancreas, though in the living animal it is kept apart from the insulin. It should be stated here that various chemists have been able to obtain insulin in the crystalline condition from the pancreas of different animals, but whilst the crystals were similar in shape and physiological activity they exhibited slight differences in composition, chiefly with regard to their contents of water and sulphur.

Adrenaline.

Adrenaline is a comparatively simple substance, which is synthesised in the body and very small quantities pass into the blood-stream. Its main function appears to be keeping the various organs sufficiently stimulated. Addison's disease has long been known to be connected with the supra-renal glands, apparently due to their failure to furnish the blood with adrenaline. Adrenaline may be prepared either from gland-extract or purely by the synthetic methods of organic chemistry. Injection of adrenaline direct into the blood-stream soon puts the body into a condition suitable for violent muscular activity. The digestive processes are arrested and the supply of blood to the digestive organs is reduced. On the other hand, the output of blood from the heart is increased, which blood is available to the muscles. Besides nervous effects, this action puts the animal in the condition in which it can exert its utmost physical power. The adrenal glands of man contain about 0·001 gram of adrenaline. The chemical formula of this remarkable substance is



It is used in surgery, especially in conjunction with local anæsthetics, as it tends to drive the blood away from the point at which it is injected.

Thyroxine.

Thyroxine is a drug, manufactured in the thyroid gland, and appears to be especially connected with the control over the growth and metabolism of the cells of the body. As the result of the labours of Kendall, Barger and Harington our knowledge of this hormone is more complete than that of any other hormone yet discovered. Congenital deficiency of this chemical messenger causes almost every organ in the body to undergo abnormal development. This is especially so in the case of the cretin. Disease ensues if the production in adults is either insufficient or excessive, the latter being considered as the cause of Graves' disease or exophthalmic goitre. Ordinary cases of goitre are usually due to deficiency. No less than 67% of thyroxine is iodine, the remaining substances being carbon, oxygen, hydrogen and nitrogen. As the iodine content of one's food is usually exceedingly small, it is likely that the use of "iodised" table salt, now obtainable, may be beneficial, especially to persons having ordinary goitrous tendencies. The amount of thyroxine in the thyroid gland of an adult is less than 0·02 gram, and the amount circulating in the blood-stream is about 0·01 gram. It thus appears that, in cases where the administration of thyroid gland extract is necessary, the dose must be exceedingly small, the therapeutic dose being 0·001 gram. Larger amounts may lead to undesirable complications. For medical use it is more convenient to use glandular extracts of sheep and oxen rather than the thyroxine itself, as it happens to be insoluble in water.

Pituitary Hormone.

This hormone is prepared in the pituitary gland which lies at the base of the brain. Though the pure hormone has not yet been isolated, pituitary gland extract is finding use in obstetrics.

Formerly it was considered that the activity of the heart was determined largely by the control of the nervous system. It is now believed that the contraction of the heart is brought about by a wave of excitation which originates and is conducted through the muscles of the heart. The function of the vagus and sympathetic nerves is to modify both the frequency and the force by which the heart responds to these impulses. Loewi has shown that the excitation of the vagus modifies the activity of the heart by causing the cells around the heart to release the chemical, *acetyl-choline*. The sympathetic nerves probably act by releasing *adrenaline*. The amount of acetyl-choline liberated is extremely small, for in large amounts it has a surprisingly great physiological action in reducing the blood pressure. Another drug, present in the blood, that has an effect on blood-pressure is *histamine*. It, or a substance of similar nature, is set free when tissues are injured, when it causes the capillaries in the vicinity to be dilated.

In conclusion, it will be seen that whilst our knowledge of the influence of vitamins and hormones is still in its infancy, sufficient is known to show the far-reaching effects which extremely small quantities of these essential factors may possess.

ANÆSTHETICS

Anæsthetics cause insensibility, which may be either general or local. General anæsthesia is produced by the action of the anæsthetic on the central nervous system, and its duration varies directly with the vapour pressure of the anæsthetic in the blood and consequently with its vapour pressure in air. In local anæsthesia, the action on the central nervous system is not general, but sets up a paralysis or sensation at, or near, the point of application rather than a complete loss of consciousness. Local anæsthetics influence various parts of the nervous system. They can act at nerve centres, which may be slightly further from the point of operation ; they may act at some point still nearer to the brain, as in the so-called block anæsthesia, in which the limb or part of the body may be anæsthetised by the action of the drug on the nerve trunk which supplies the area ; lastly, the anæsthesia may be produced from the central nervous system itself.

The anæsthetic power of certain herbs has been known from the earliest times. It is referred to in the writings of Homer and Pliny, and a Chinese surgeon administered hemp preparations during his operations in the third century. The use of anæsthetics in modern times appears to date from the observations of Davy regarding the action of nitrous oxide, or "laughing-gas" as it is more usually known. Faraday noted the anæsthetic action of ether vapour in 1818, but it was not until Jackson, in 1841, in Boston, U.S.A., found his laboratory attendant anæsthetised as the result of the explosion of a vessel containing ether, that its value began to receive attention. In 1846, Dr. Morton of Boston, used ether vapour in tooth extraction, and later in the same year he used it to perform the first surgical operation with an anæsthetic, viz., the removal of a tumour of the neck. Chloroform was used in Edinburgh by Dr. Simpson in 1847 in connexion with childbirth. Alexander Wood, of Edinburgh, made the first hypodermic syringe, having a hollow needle so that drugs could be injected directly into the blood-stream. He used morphine, opium and chloroform. The last caused more pain during administration than was caused by the operation. Although Neumann isolated a drug, cocaine, from the South American cocoa-leaf in 1857, it was not until 1884 that Köller discovered its valuable anæsthetic properties. The use of cocaine with the majority of people is safe, though in certain persons it is a powerful cardiac depressant and may cause speedy death. In a few people its use gives rise to a craving for the drug, and the cocaine-habit ("doping") may lead to mental and moral degradation and often to imbecility. Another disadvantage is that it cannot be sterilised by boiling. In spite of this, its efficiency as a local anæsthetic is high. Other local anæsthetics have therefore been sought. Many have been introduced: eucaine, beta-eucaine, stovaine, novocaine, to mention only a few. They all have their peculiar disadvantages, though novocaine possesses the virtues of all and the vices of none. Besides being a non-irritant, it is the least poisonous, can be sterilised by boiling, and possesses slight antiseptic properties. Whilst it is not quite so powerful as a local anæsthetic as cocaine, larger doses can be safely given, and if injected with adrenaline, so as to contract the blood vessels, the action of the drug can be centralised at the point of operation. The chemical formula of novocaine is