

VI

VITAMIN D, THE SUNSHINE VITAMIN, AND OTHER FAT-SOLUBLE VITAMINS

ALTHOUGH the human race began to suffer from vitamin A deficiency soon after it learned to cultivate and store grain and to live upon it too exclusively during unproductive seasons or in lean years, widespread injury from insufficient vitamin D came much later. It became a major human scourge when the development of industrialism and the growth of great cities in the northern part of Europe deprived mankind of sufficient sunshine. This is because exposure to sunshine is necessary for the formation of vitamin D in our own skins from a mother substance which seems always to be present in abundance.

The combination of window glass, smoke, slums, and malnutrition which arose during the sixteenth and seventeenth centuries in Europe was too much, even for our stalwart forefathers, in a locality in which sunshine was already diluted almost to the vanishing point by fog and latitude. From that time until the beginning of our present century, rickets, which comes from lack of vitamin D, was the commonest disease of children under two years of age. Children with extreme deformities were very common. Everywhere there were to be seen bowlegs, knock-knees, deformed wrists and ankles, protruding foreheads, potbellies, and "rosaries" along the sides of the chest. Most of the children later outgrew these troubles, but not all, and a roving eye on a modern bathing beach can still pick out a fair number of

middle-aged people, who were babies some forty years ago, whose legs would spell "OX" if they stood together in properly assorted pairs.

In the northern European cities, and in our own, from 80 to 90 per cent of the babies formerly showed some evidence of rickets. Very few babies in Boston or New York, especially those born in winter, escaped it, and among the black babies of Harlem and the dark "bambinos" of the East Side one could have searched in vain for an example of what the well-fed baby should look like. In a survey made in New Haven about 1925, 96 per cent of children examined by X-ray showed evidence of rickets at some time before they were eight months old, even though over half of them were given preventive or curative treatment. Even in New Orleans rickets in milder form was very prevalent, for there are many cloudy murky days, and when the sun does shine, at least in summer, it does it with such reckless abandon that mothers take siestas in darkened bedrooms, children play in cellars, and babies are perambulated in the moonshine.

Today, with sunbaths and ultraviolet lamps among our most popular health hobbies, and cod-liver oil or other rich sources of vitamin D almost as much a matter of routine in the raising of a baby as castor oil or orange juice, the day of obvious rickets has gone the way of witchcraft and louse-repelling sachets, and it is only seen in the most benighted parts of the civilized world. *Early* symptoms of vitamin D deficiency are still very common in infants and "overbearing" but underfed mothers in the North Temperate Zone, but they are not often, nowadays, severe enough to leave indelible marks.

Vitamin D is a fat-soluble substance like vitamin A. It was many years before the two were separated from each other, for most foods which supply vitamin D supply some

212 Vitamins in Human Nutrition

vitamin A also. Then it was found that cod-liver oil in which all vitamin A had been destroyed was still able to prevent rickets. Vitamin D went through the process of being born into the scientific world in 1921 and 1922, and was christened in 1923.

Vitamin D is formed by the action of ultraviolet light rays on certain wax-like substances, related to fats, which are known as "sterols." Cholesterol, very abundant in animal bodies, is one of these sterols, but pure cholesterol is not one of those which light can change into vitamin D. However, it is accompanied by a related substance, possibly derived from it, which *is* changed into vitamin D when bombarded by ultraviolet rays. When the skin is exposed to sunlight the production of vitamin D from this hanger-on of cholesterol takes place. An identical form of vitamin D is found in the livers of fishes, along with certain other forms. Another sterol, called ergosterol, which is changed into a different vitamin D by the action of light, is found abundantly in yeasts and various fungi. A still different form of vitamin D results from the irradiation of higher plants. Altogether eleven different varieties of vitamin D are known.

The only place in Nature where vitamin D is found abundantly under conditions which do not suggest its formation from mother substances by the action of ultraviolet light is in the oil of fat-livered fishes. There is good reason to believe that these fish actually manufacture vitamin D in their livers without the aid of light, for they live in northern waters where ultraviolet light must be as scarce as in a New York tenement house in winter, and they feed on smaller organisms that likewise live where they would never need to worry about getting sunburned. One other explanation that has been offered for this mystery is that seaweeds or plank-

ton in the clear sunlit waters of the Caribbean might be the original source. Vitamin D has actually been found in oil extracted from Sargassum weed. Enormous quantities of the weed are carried northward by the Gulf Stream; meanwhile its vitamin D is taken up by countless tiny marine molluscs and crustaceans which feed on it. These pass the vitamin on to shrimp and sardines, and these in turn yield it up to the large tunas and cod which migrate with their drifting food factories. Thus eventually the vitamin D finds its way to the great human fish centers of Europe and America, and thence as cod-liver oil to the shelves of drugstores in every town and hamlet in the world. Against this idea, however, is the fact that when pure flavorless vitamin D is distilled from the livers of various fish by the recently devised vacuum distillation process, different kinds of fish are found to have their livers charged with different brands of vitamin D. The tuna fish brand, for instance, is different from the sea-bass brand, and even cod-liver oil contains two major varieties and several minor ones.

Unfortunately the livers of land animals are unable to function like those of fishes. This results in an important difference between the mother substances of vitamin A and those of vitamin D, for while carotene is as useful a food as vitamin A because it can always be converted into vitamin A in our own bodies, the forerunners of vitamin D cannot be so changed except on exposure to ultraviolet rays.

Very few natural foods contain appreciable amounts of vitamin D. Milk, butter, eggs, liver, and fat-fleshed fish practically complete the list. The oil of fat-livered fishes is the most potent natural source, and it is from this and from irradiated yeast that we obtain our concentrated forms of vitamin D. Pure "calciferol," the most potent product of irradiated ergosterol, is 400,000 times as potent as cod-liver

214 Vitamins in Human Nutrition

oil. Yet to equal a teaspoonful of standard cod-liver oil it takes about eight quarts of summer milk from sunbathed cows, sixty quarts of winter milk, twelve to sixteen ounces of butter, two pounds of liver, five eggs from outdoor hens in summer, or about a dozen winter eggs. Human milk is never very rich in vitamin D, even when mothers dutifully take cod-liver oil to supply it. Moderate exposure of the body to summer sunshine or to rays from a mercury vapor lamp is in most individuals an adequate substitute for *any* vitamin D in the food. Nevertheless, giving babies cod-liver oil or vitamin D concentrates of some kind is usually far less troublesome than irradiating them.

Vitamin D may also be supplied to human beings by being added to foods, or formed in them by irradiation. These methods have been most extensively and effectively applied to milk. The vitamin D content of milk may be increased by any one of three methods: direct addition of it (fortified milk); feeding of irradiated yeast to the producing cows (metabolized milk); or irradiating the milk itself, in which case enough provitamin D is activated to provide a minimum of about 135 units per quart.

The effectiveness of sunlight as a means of forming vitamin D in our own skins depends upon its content of the particular ultraviolet light rays needed. The effective light rays are largely filtered out by the earth's atmosphere, especially when this is full of fog, smoke, or dust, or when the light has to travel through a much thicker layer due to a low position of the sun above the horizon. It is for this reason that sunlight, even if there is any, is largely or completely robbed of the effective ultraviolet rays in the far north, in most of Europe and North America in winter, and in foggy cities like Glasgow and London, or smoky cities like St. Louis and Pittsburgh almost any time. On the other hand, in the

tropics, at high altitudes or on sunny beaches, if the sun is taken advantage of, cod-liver oil is as needless as is rain on the ocean. Water, and snow even more, reflect the ultra-violet rays and so increase their availability, as every par-boiled bather and mountain climber knows. When the sunlight contains plenty of the desired rays, even the "sky-shine" of shaded places is effective, since these rays are well reflected. Ordinary window glass completely bars them out.

Animals obtain most of their vitamin D by their grooming operations. A cat licking her fur is getting her daily vitamin D as well as taking a bath. Wool fat and skin oils in general are rich in provitamin which is changed to vitamin D on exposure to light. If animals are not allowed to lick their fur they get no benefit from sunlight. Carnivorous animals get vitamin D from the fur and feathers of their prey. Birds anoint their feathers with a provitamin D provided by the oil gland. Since birds have no glands in their skins except this one, they suffer from rickets when it is removed, in spite of exposure to sun.

It will be welcome news to small boys that too frequent washing of human skin, especially with soap, is an unhygienic procedure, for it removes too much of the sebaceous skin secretion out of which sunshine produces vitamin D. Too great addiction to bathing may necessitate the use of cod-liver oil even in the tropics. It is evident that Nature did not intend human beings to be semi-aquatic.

It seems from these facts that a good deal of the vitamin D formed in human skin is really formed *on* it and then re-absorbed. It is possible to cure rickets in rats by applying vitamin D preparations to the surface of the skin, but it takes about ten times as much as when it is given by mouth. This seems to be a good argument against using it as a "skin food" instead of eating it. However, in cases of obstructive

216 Vitamins in Human Nutrition

jaundice, application to the skin might be desirable, for vitamin D, like vitamin A, is not absorbed from the intestine in the absence of bile.

The mode of action of vitamin D is rather complicated because it is only one of several factors concerned in its sphere of influence. It has a specific effect on the absorption, retention, and distribution of two minerals in the body—calcium and phosphorus. Both are absolutely essential to life, from the moment of conception to death. They are intimately concerned with the never-ceasing metabolism of every living cell in the body. But in addition bones and teeth are made of a combination of these two elements. Nature loves to kill two birds with one stone, and does it every time an opportunity offers. Just as she makes use of stored fat as an insulator and shock absorber, so she makes use of stored calcium and phosphorus as the props and barrel staves of the skeleton. In both cases the more vital functions come first, and if there is a scarcity the inactive stores, however helpful they may be in a mechanical or physical way, have to depend on what is left over, or go without. And if the scarcity becomes more acute the inactive stores are actually melted down and used, just as gold ornaments might have been melted down and used for currency in times of stress.

When calcium or phosphorus or both become scarce in the body, the normal process of bone formation ceases. Normally during bone growth the cartilage which precedes the bone (all long bones have growing cartilaginous regions near their tips) is eroded away and bone cells come in, depositing calcium phosphate as they multiply. When there is a deficiency of either one or both minerals, no calcium phosphate is formed and the cartilage is not eroded away, but bone cells accumulate just the same. The consequence is that the bones remain soft and weak, bend under pressure, and

enlarge at the joints. Hence the bowlegs, square heads, knock knees, pigeon breast, deformed pelvis, bulging ankles, and the row of bead-like enlargements where bone and cartilage join on the ribs, so aptly called the rhachitic rosary.

Teething and walking are delayed. Both the dentine and the enamel of the teeth are imperfectly deposited, and the teeth become soft and porous, and susceptible to decay. A recent survey of 1,400,000 American children showed that in the northern states 76 per cent had cavities in their permanent teeth, with an average of 293 cavities per 100 children, while in the South only 60 per cent had cavities, with an average of 202 per 100 children. It is probable that sunshine had more to do with it than either diet or table manners. As noted before, many of the defects of vitamin D deficiency are later corrected, but the deformities of teeth and pelvis are liable to persist. The latter may cause much grief later in life when child-bearing begins.

Exactly how vitamin D keeps the calcium and phosphorus regulated and functioning properly is not fully known. It undoubtedly makes the absorption of minerals more efficient, and impedes their excretion, but it is also concerned with the form they take and the distribution of them inside the body. For example, vitamin D probably increases the phosphorus in the blood to a point where it is properly balanced with the calcium for bone forming, by releasing it from lecithin or other organic combinations. If the minerals in the diet are badly off balance when rapid growth is occurring, there is a heavy demand for vitamin D.

It is most often in babies from six to eighteen months old that rickets develops. It rarely develops before birth due to the efficiency of the placenta in taking minerals from the mother, combined with the wise and merciful provision of Nature which keeps babies flexible by postponing the exten-

218 Vitamins in Human Nutrition

sive storage of calcium and phosphorus in the bones until after birth. When the infantile period of very rapid bone growth slows up, outdoor life begins and more varied food is eaten. Increased minerals, sunshine, and vitamin D in the food, any one or all, not only stop the disease but usually cure it.

The same conditions which lead to rickets in infants sometimes, but much less frequently, lead to a disease called osteomalacia, or softening of the bones, in adults. Immediately following the World War there developed in Vienna and other Central European cities a condition of weakened legs, painful bones, waddling gait, and posterior lap (due to abnormal spine curvature), which was called marmalade legs in tribute to one of the outstanding features of the much restricted diet. The widespread misery of those dark days came while help was close at hand—it never would have happened if the brilliant discoveries concerning the value of ultraviolet rays and vitamin D had come a few years sooner. Oddly it was almost entirely confined to men.

In almost every other known instance osteomalacia is primarily, and almost exclusively, a disease of women. Presumably the hormones from the ovary are somehow involved in it, for it usually develops at times when the reproductive system is especially active—at puberty, during pregnancy, and while nursing. It develops especially in mothers who do more than their share towards keeping up the quantity if not the quality of the human race.

It was formerly thought that it was the drain of minerals by the fetus or nursing baby that caused this condition, but the fact that it very commonly develops just at puberty, and during the early part of pregnancy when no baby bones are yet being formed, points to the ovaries as the disturbing factor. As much as two-thirds of the minerals in the bones

may be melted away, and the softening of the skeleton may go so far as to make walking or even standing impossible. The pelvis is especially likely to be deformed so that natural births become difficult or impossible. Wherever Caesarean sections are unduly prevalent there is probably need for sunlight, minerals, or vitamin D, one or all. Severe lack or wasting of calcium also causes tetany, in which the muscles twitch and convulsively contract. This is due to an over-excitability of the nerves which always follows insufficient calcium in the blood.

In addition to its principal business of regulating the behavior of the calcium and phosphorus in the body, vitamin D undoubtedly has other minor functions. It stimulates metabolism, as does the thyroid gland; hedgehogs given it fail to go to sleep for the winter. Because of its effect on phosphorus it is important in connection with numerous other affairs of the body with which this element is concerned. Vitamin D may also prove to be a godsend to adolescents, for recently it has been found to give excellent results in the treatment of acne and other skin conditions, and few things are more mortifying than acne to sub-debs or their suitors. There is, however, little justification for taking this or any other vitamin externally in cosmetics instead of internally.

Usually both rickets and osteomalacia go hand in hand with poverty, since dark, crowded quarters and inadequate diets usually fall to the lot of the poor. But in India the opposite is true—the better class Mohammedan women, and in most places the highest caste Hindu women, whose part-time husbands may be wealthy enough to clothe them in pearls and feed them on hummingbirds, live their entire adult lives in purdah, secluded in poorly lighted rooms furnished with jewel-studded walls and alabaster baths, but with few or no windows. Their only outings are on the occa-

220 Vitamins in Human Nutrition

sion of family marriages or deaths, or of religious ceremonies, when they go forth draped somewhat more effectively than a Ku Klux Klansman at a lynching. Among these women, fed on the richest food money can buy, osteomalacia is more common than it is in the slums of New York, and many of their babies have rickets, while among the teeming millions of India's lower castes who are abundantly exposed to the sun, rickets and osteomalacia are practically never seen. In parts of China, also, osteomalacia is prevalent among a certain class of women—not the poor ones, who have to work in the fields, or the rich ones who can add meat and fat to their diet of millet gruel, but those who are too proud to work but too poor to eat well.

The speed with which improvement in rickets and osteomalacia can be brought about is amazing. Deposit of lime and resumption of normal bone growth may begin within twenty-four hours after cod-liver oil is administered, but in severe cases it may take several months of treatment to get complete cures. Three teaspoonfuls a day is usually considered a good curative dose, but rapid cures of bad cases may require considerably more. Although excessive doses of vitamin D have been found to cause premature calcification of bones, and deposits of calcium where none should be, and also to produce other toxic symptoms, the doses necessary to produce these effects are thousands of times larger than the ordinary doses, so danger of too much vitamin D is too remote to cause any worry to a mother or physician.

Occasional individuals require much larger doses of vitamin D to cure or prevent rickets than the average. Premature babies sometimes need 10,000 to 20,000 units a day, and there is one case of a boy of sixteen years, whose rickets had persisted from infancy in spite of orthodox methods of

treatment, to whom 1,000,000 to 1,500,000 units a day had to be given before healing began, and when recovered he had to get 150,000 a day to keep him normal. Before modern methods of concentrating vitamin D were invented it would have been impossible to cure him, for it would have taken ten to fifteen quarts of cod-liver oil to supply the necessary number of daily units. The unconcentrated liver oil of the blue-fin tuna is 400 times as potent as cod-liver oil, and some vitamin D concentrates are several thousand times as potent. Nowadays the oils extracted from the livers of various kinds of fish are mixed together in such a way as to provide 100 times as much of both vitamin A and vitamin D as standard cod-liver oil.

Large doses of vitamin D have been found by some scientists to be effective, sometimes at least, in the treatment of a number of conditions in which its function is more obscure than in rickets. Among these are celiac disease, arthritis, hay fever, psoriasis (a common skin disorder in the North), milk fever, and even near-sightedness. It is also claimed to increase resistance to infantile paralysis, and to hasten the healing of wounds when locally applied.

VITAMIN E, THE STORK VITAMIN

During the post-war days when the goodness of a diet had been found to involve more than calories and proteins, and the new alphabet of vitamins was becoming a prominent feature of nutritional studies, two scientists at the University of California made an interesting observation. Their female rats fed on a diet containing all the vitamins a rat was known to have any use for were found to be perfectly normal in every respect except their inability to produce families. They had normal sex cycles, normal conceptions,

222 Vitamins in Human Nutrition

and began their pregnancies in a normal manner, but they never became more than expectant mothers. Their young died in the uterus after the middle of the period of pregnancy (which is twenty-one days) and were re-absorbed. Suspecting that this might be a rat's reaction to lack of vitamin C, which rats were supposed not to need in their food, these scientists added orange juice to the diet of one group of rats, and lettuce to that of another. Only about one in each five or six of the orange-fed rats succeeded in producing a litter, whereas the lettuce-fed rats all had blessed events.

This was the beginning of knowledge of a special substance in the diet without which normal reproduction fails, at least in rats. Subsequently it was found that this substance, which was christened vitamin E in 1923, is necessary for rapidly multiplying cells. In the female, which produces only one egg to millions of sperms in the male, the lack of the vitamin produces no effect in the ovary, but does affect the rapidly multiplying cells of the fetus and also the placenta, through which the fetus is nourished. In males, on the other hand, the cells lining the tubules of the testes, from which millions of sperms are constantly being formed in adult life, are among the most rapidly multiplying cells in the body. A male rat deprived of vitamin E at first has normal sex power and apparently normal sperms, but the sperms fail to fertilize the eggs. Subsequently no sperms are produced, then there is loss of sexual vigor, and finally loss even of sexual interest. Another site of rapid cell multiplication is in the brain of rats shortly after birth. Baby rats born of mothers deficient in vitamin E are likely to develop paralysis when about three weeks old.

Other vitamins, when fed to animals which have been deprived of them, bring about rapid or even spectacular im-

provement, but in rats damage done by lack of vitamin E is usually there to stay. Feeding of vitamin E begun after five days of pregnancy is too late to save a litter. Males sterile from lack of the substance sometimes recover but it takes nearly a year of treatment, which brings a rat close to middle age. A very small amount of the vitamin enables female rats to become mothers if given in early maturity, but as the rats grow older they require more and more. Rats deprived of vitamin E until over a year old are never able to reproduce however much of the fertility vitamin they are then given.

That vitamin E may have other functions is indicated by the fact that rabbits and guinea pigs experience a wasting away of their muscles when deprived of it, and can be cured by its administration.

As has been observed before, what is good for a rat is in most cases good for human beings also. There is strong evidence that vitamin E is necessary to mankind as well as to rats for successful reproduction, and that occasionally human beings may be inadequately supplied with it in their normal diets. Largely on the basis of its effects in rats it has been postulated that inadequate vitamin E in human beings might lead not only to a high abortion rate in women but to a low rate of fertility in men.

Many cases of sterility are correlated either with too few sperms, or inactive or lifeless ones, or a high percentage of misshapen ones. Sometimes these defects respond to continued treatment with pituitary extract, but often they do not, and in many of these cases there is no good explanation for the condition. In view of the effects of insufficient vitamin E on male rats, it is possible that the human males who are unable to contribute to posterity on account of the production of too few, too sluggish, or imperfectly formed

224 Vitamins in Human Nutrition

sperms may be suffering from too little of vitamin E, or inability to assimilate it.

There is growing evidence that during pregnancy a deficiency of vitamin E is much commoner than had been supposed. Drastic changes in metabolism occur during pregnancy; more vitamins than usual are needed, and relative deficiency in one or all may be the cause of many of the discomforts and accidents that go with child-bearing. A few years ago a Danish doctor treated twenty women, who were given to habitual abortions, with wheat germ oil, the richest known source of vitamin E, and seventeen of them gave birth to normal nine-month babies. A doctor in England gave three small capsules of extract of wheat germ oil daily to a series of expectant mothers for an average of five months before their babies were due, and got only one abortion in a group of twenty-three mothers who previously had a record of only eleven living children out of seventy-three pregnancies, five of which died immediately after birth. Two doctors at the University of Western Ontario gave 2 or 3 drams a day of wheat germ oil to forty-six women who had a history of one or more previous abortions, and got thirty-four normal deliveries, and of nineteen other cases of threatened abortion, thirteen produced normal babies.

Another man at the same Canadian school has found that vitamin E is also an excellent treatment for premature separation of the placenta from the uterus. When extensive, this causes severe shock, often with profuse bleeding, and leads to the death of the fetus and often of the mother as well. More commonly the separation is only partial, causing mild bleeding, pains, and tenderness in the uterus, severe aches in the lower back, and often abortions. In these cases consistently good results were reported from treatment with wheat germ oil if begun early enough. A

simple chemical test of the serum by which an inadequate supply of vitamin E can be detected has also been reported, making it possible to diagnose vitamin E deficiency without guessing at it. Apparently vitamin E has a neutralizing effect on the ovarian hormone (oestrin); when this hormone is too abundant it interferes with the burrowing into the uterine wall of the placental villi which make for a firm union. The blood of a high percentage of women with spontaneous abortions is said to show evidence of vitamin E deficiency by the serum test, but a normal condition is restored by a single large dose (6 to 12 drams) of wheat germ oil, or repeated smaller doses of 2 to 3 drams daily for a few days. Possibly lack of vitamin E will be found to be the underlying cause of other obscure reproductive ailments.

Vitamin E, like A and D, is soluble in fats. It has recently been obtained as a pure chemical known as alpha-tocopherol. It is not injured by cooking, drying, or ordinary exposure to air, but is quickly destroyed by rancidity of the fats in which it is dissolved, and also by some iron salts. It is very widely distributed in Nature, having been found in green leaves and other vegetable foods, as well as in the meat, fat, eggs, and milk of animals fed on E-containing foods, but it is particularly abundant in the germinal parts of seeds. The most abundant source so far known is wheat germ or rice germ oil. Most people certainly obtain plenty of vitamin E in their usual diets, but there is evidence that in rats some individuals, even among litter mates, assimilate and store vitamin E far less readily than others, and this may also be true of human beings. Probably an unusually large amount is required during pregnancy to react with the large quantity of oestrin formed or stored in the placenta, and it is only then that the effect of diets low in this vitamin would become apparent. It is doubtful whether special food preparations

226 Vitamins in Human Nutrition

rich in vitamin E should be advertised as general stork lures, but the use of such foods or of the extracted oil of seed germs is certainly desirable in cases with histories or premonitions of abortion, and might well be tried on both partners, but particularly the man, in the six or eight cases of sterility out of every hundred that cannot be accounted for on the basis of diseased or abnormal anatomical conditions.

VITAMIN K, THE BLOOD-CLOTTING VITAMIN

A few years ago it was discovered that chicks fed on certain experimental diets which contained the entire quota of vitamins and factors known up to date developed a tendency to bleed—from cuts, broken pin feathers, or apparently without provocation—and just kept on bleeding. Examination of the blood showed that it lacked prothrombin, an essential ingredient which enables blood to clot on exposure to air. The chicks could be saved from bleeding to death by addition of only 1 per cent of dry alfalfa to their food, whereas 2 per cent brought them back to normal. It was also observed that their feathers grew better when the alfalfa was added. Further investigation showed that the new food factor, christened vitamin K, is a fat-soluble substance found in unusual abundance in alfalfa, but also present in various other vegetables, such as cabbage, spinach, and tomatoes, in the liver fat of hogs, and in fish meal.

Within the present year the chemical nature of vitamin K has been determined and a pure synthetic form of it—a naphthoquinone—has been manufactured. This is so potent that one gram of it is equivalent to the extract from 500 lbs. of alfalfa.

Although the bleeding disease has not been induced in animals other than chicks by giving a diet deprived of vita-

min K, there is good evidence that this vitamin will cure unrestrained bleeding wherever prothrombin is deficient. In cattle and rabbits, for instance, a loss of prothrombin results from eating improperly cured sweet clover. This can be prevented by adding 5 per cent dry alfalfa to the feed.

In human beings surgeons have long been worried about what to do in cases of "obstructive jaundice." This is a condition in which the bile ducts get clogged up so the bile is unable to reach the intestine and is deposited elsewhere in the body, causing the sufferer to acquire a saffron-tinted skin and eyes. The obvious procedure would seem to be an operation to open a passage through the stopped-up tubes, but this is often impossible because in obstructive jaundice the blood frequently fails to clot, in which case the patient would promptly bleed to death. Some doctors at the Mayo Clinic, pondering over the effect of alfalfa on bleeding chicks and rabbits, and believing the bleeding of their jaundiced patients might be the result of inability to absorb fat-soluble vitamin K in the absence of bile, began feeding their cases on alfalfa meal, but since the patients did not take kindly to this, they later used fish meal instead, along with some bile to facilitate absorption, and got very good results.

Another very promising use for vitamin K is in the prevention and cure of bleeding in new-born babies. During the first few days of life the blood-clotting time of babies is likely to fluctuate so a graph of it looks like a stock market chart during a series of war scares, but by about the fifth day it steadies down and remains at a reasonably low level. Meanwhile even a very small bleeding point may lead to great loss of blood. In such cases a single dose of vitamin K concentrate may, within one and a half to two hours, cut the blood-clotting time in half. Bleeding inside the brain case is responsible for from 25 to 40 per cent of deaths of new-born

228 Vitamins in Human Nutrition

babies; few maternity hospitals escape without at least one case in 100 to 150 births, and many of the babies so unfortunate as not to die become physical and mental cripples. Some doctors at the University of Virginia think that many of these cases, caused by slow, oozing hemorrhages from small bleeding points, could be prevented by giving vitamin K immediately after birth, or perhaps by giving it to the mother shortly before delivery. It might also be of benefit to mothers who are slow to stop bleeding after the birth of a baby. With the recent development of a pure synthetic form of vitamin K which can be intravenously injected, it is probable that a much wider use will be made of it.

A fatty substance has recently been obtained from animal livers which has a remarkable effect in checking excessive menstrual bleeding; the relation of this "anti-menorrhagic factor" to vitamin K is still somewhat uncertain.

In conclusion it should also be mentioned that injection of small amounts of oxalic acid, a well-known ink remover, also has striking effects in causing blood to coagulate. This might well be included in a "believe it or not" column, since salts of oxalic acid in larger amount have long been used to *prevent* coagulation of blood which has been drawn for experimental purposes.

THE USE OF SUPPLEMENTARY VITAMINS

It is obvious from what has been said about the important functions of the various vitamins, and about the extent to which they may be missing in modern American diets, that the use of supplementary vitamins is often desirable, or even necessary, to insure maximum health.

Modern methods of concentrating vitamins or of synthetically manufacturing them have made it possible to sup-

ply them in purified form at no appreciably greater cost, if not actually cheaper, than foods naturally containing them. The use of such purified vitamins would in the past have been undesirable because we were not certain just what vitamins a human being really needed. If we had attempted to substitute thiamin (pure vitamin B₁) for the vitamin B complex found in natural foods, we would have deprived ourselves of such other necessary vitamins as nicotinic acid, riboflavine, and possibly others. It is not certain that we know all the vitamins we need even yet, and it is possible that the use of entirely vitaminless food with purified vitamins added would bring to light hitherto unsuspected food requirements, as it has done in the case of experimental animals.

However, we could probably get along excellently with any ordinary foods for which we might take a fancy, as long as they supplied us with adequate calories and proteins, if we supplemented them with known vitamins and minerals in a concentrated or purified state. With the use of such preparations we could give our appetites much freer rein, and we could cease to worry very much about the likes and dislikes of little Willie.

Few people would need or desire to get all or even most of their vitamins or minerals in pills, but it would constitute an excellent "diet insurance" for people who are reducing; for people with finicky appetites, diabetes, irritable digestive tracts, or other conditions interfering with normal food consumption; and for people suffering from food shortages on expeditions or in times of war or famine. It will probably not be long until we are adding vitamins and minerals to staple foods as we already add iodine to salt. We already look favorably on cod-liver oil and orange juice as adjuncts to a baby's diet, purely for their vitamin content. We may soon be getting thiamin in our sugar, nicotinic acid and

230 Vitamins in Human Nutrition

riboflavine in our salt, pure distilled vitamins A and D in our milk or butter, vitamin C in our citrus or tomato juice. As Dr. Milo Hastings remarked in a recent article, "the fact that man frequently errs by flouting nature does not prove that he cannot beat nature at her own game by stealing her thunder and making it louder. Much of human progress has been achieved in that fashion."

When symptoms of vitamin deficiencies have actually made themselves apparent, it is nearly always necessary to turn to concentrated or pure vitamins for treatment. Such symptoms result from long-continued lack of vitamin-bearing foods, improper preparation of them, or failure to absorb them in a normal manner. To correct such conditions requires drastic changes in dietary habits, which are often difficult because man is a creature of habit and has a tendency to develop strong likes and dislikes with respect to his victuals. Moreover, it may be necessary to give a great excess of one or several vitamins until a normal condition is restored. It would often be physically impossible for a person to eat enough food to obtain the amounts of vitamins needed to bring about a reasonably rapid cure of such conditions as scurvy, pellagra, beri-beri, and rickets.

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