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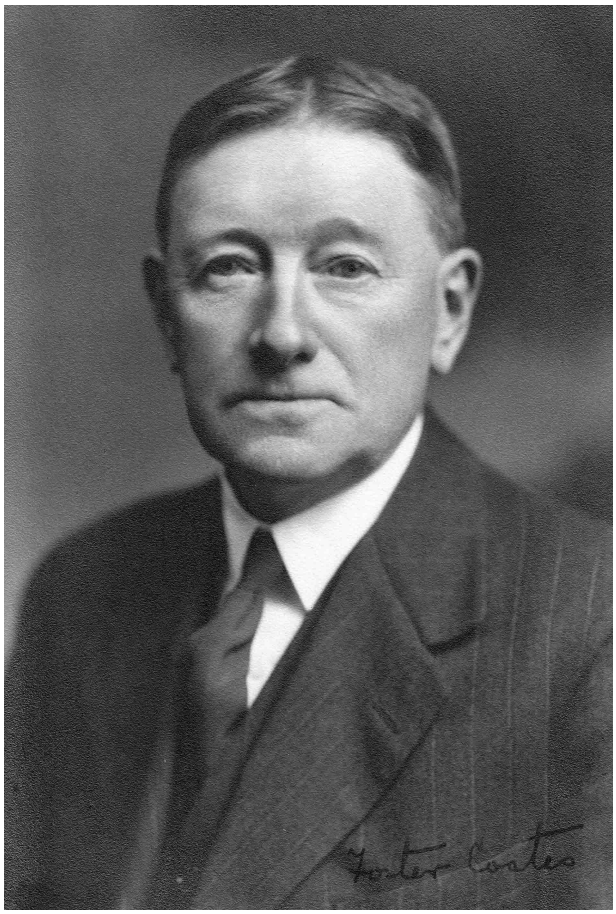
THE IMPORTANCE OF VITAMINS IN DIETETICS



IT is my intention this evening to give you a brief survey of the work which led to the discovery of vitamins, and of the important part they play in nutrition and dietetics.

The whole subject is reviewed at length in the report published by the Medical Research Council in 1932, and it is largely from this report that the subject matter of my address has been compiled.

Vitamins perform very important nutritional functions in life, yet only minute amounts are necessary for the adequate fulfilment of these functions. In ordinary diets they are present in quantities far too small to yield any appreciable contribution to the energy supply of the body, or to furnish structural elements for the tissues.

Since a supply of vitamins is essential for the animal body, these are generally present in the natural foods which are instinctively consumed by men and animals.

Vitamins are primarily formed during the synthetic activities of the green plant on land, or of algae or other organisms in the sea. From these they are transferred to the tissues of animals.

The distribution of vitamins in vegetable and animal foods may be partial and irregular, but, broadly speaking, it is safe to say that the adult individual finds a sufficient supply of vitamins in his food, so long as that food is reasonably varied.

Yet should the natural foods be specially purified and fractioned for the sake of taste or appearance or, for convenience, be preserved in various ways, it frequently happens that the vitamins, owing to their partial distribution, may be removed or, owing to their relative instability, destroyed.

It was from the rice-eating countries, especially in the East, where the diet is not sufficiently varied, that we first had evidence of the ill-effects which might arise from the artificial treatment of food.

When modern milling machinery was introduced, the rice thus treated was deprived of vitamins which were present only in the cortex. The consumption of this decorticated, or polished, rice led to the development of beri-beri.

It was long before the importance of food factors was recognized, as disease was always considered to be due to some positive agent, microbic or toxic, and it was difficult to conceive that it could also be caused by a negative agent, that is, by the absence of some apparently unimportant factor. But when this fact became clearly established, we were able to supplement clinical and sociological observation by controlled experiments on animals.

Although it was known for centuries that scurvy was due to a diet containing an inadequate supply of green vegetables and fruit, yet it was not till 1881 that evidence of the existence of vitamins, based on animal experiments, was furnished by Lunin, one of the workers from the school of Bunge at Basle. Lunin was investigating the role played by the inorganic salts in nutrition. He fed mice on an

artificial mixture of the individual constituents of milk, namely, protein, fats, salts, and carbohydrates, and found that the animals failed to survive. He came to the conclusion that a natural food, such as milk, must therefore contain, besides these known ingredients, small quantities of unknown substances essential to life.

Ten years later, in 1891, Socin, another of Bunge's assistants, working on the same lines, arrived at the conclusion that some unknown substances must be present in food, substances which, he stated, must be present in whole milk and in egg yolk.

In 1897, Dr. Christian Eijkman, a military doctor in the Dutch East Indies, and later Professor of Hygiene at Utrecht, proved that beri-beri in man was due to the use of polished or decorticated rice as a staple food.

He also observed that birds (fowls, pigeons, and ducks), when fed on polished rice, developed a disease similar to beri-beri, which he called *polyneuritis gallinarum*, and that the disease failed to develop when the birds were fed on whole rice, or on rice grains still containing the pericarp or silver skin.

About 1901 another Dutch scientist, Grijns, put forward the view that beri-beri, whether in birds or man, was due to a deficiency, to the absence of an essential nutrient from the food. This in rice happens to be confined to the cortical part of the grain which is removed by polishing.

To Grijns belongs the credit of first picturing clearly what is now called a deficiency disease, and also of first investigating the properties and distribution of a vitamin.

In 1905 Professor Pekelharing, probably because he was well aware of these researches which were not generally known outside Holland, carried out similar experiments with milk, and referring to this unknown substance, stated: "If this substance is absent, the organism loses the power properly to assimilate the well-known principal part of food, the appetite is lost, and with apparent abundance the animals die of want. Undoubtedly this substance occurs not only in milk but in all sorts of foodstuffs, both of vegetable and of animal origin."

Hopkins at this time was carrying out experiments in England, and in 1906 published a paper confirming these findings. He claimed that scurvy and rickets were both due to the absence of some unknown dietetic factor, also that nutritive errors affecting the health of individuals depended on unsuspected dietetic factors.

In 1907 two Norwegian scientists, Holst and Frölich, showed that typical scurvy could be produced in guinea-pigs by deficient diets, and could be as easily cured by suitable additions to the diets.

1912 Casimir Funk, as the result of work carried out at the Lister Institute, published a paper entitled "The Etiology of the Deficiency Diseases." He reviewed the literature concerning beri-beri, scurvy, and pellagra, and advanced the opinion that all three were deficiency diseases. In this paper the term 'vitamin' was used for the first time.

In 1913 McCollum and Davis in America discovered the importance of the fat soluble vitamin contained in butter, and in 1915 they published a paper proving that at least two accessory diet factors were essential for normal growth, the one being present in butter fat, and the other being widely spread in natural food materials such as wheat-germ, etc. They suggested that these two vitamins should be called fat soluble A and water soluble B. The anti-scorbutic vitamin C was also included about this time. Up till 1918 these were the only vitamins recognized.

Between 1918 and 1921 E. Mellanby established the fact that rickets was also a deficiency disease, and could be produced in puppies by withholding from the diet a substance, the anti-rachitic vitamin, which appeared to be similar as regards distribution and properties to the fat soluble vitamin A.

Between 1922 and 1925 it was proved by many workers that the original vitamin A, contained in cod-liver oil, was composed of two different vitamins. On treating the cod-liver oil by heat and oxidation the anti-rachitic factor was unaffected, while the anti-xerophthalmic or growth factor was destroyed. The anti-rachitic factor was now named vitamin D.

It was further discovered that vitamin D, but not vitamin A, could be produced by the action of certain radiations upon the animal organism, or upon natural foodstuffs composing the diet.

It is now well known that vitamin A and vitamin D are distinct fat-soluble dietary factors, both of which are required by animals for satisfactory growth and nutrition.

About 1923 vitamin E was discovered.

VITAMIN A.

Deficiency is generally associated with the following pathological conditions:

1. Cessation of growth.
2. Xerophthalmic and infective conditions of eye.
3. Night-blindness or hemeralopia.
4. Various tissue changes.
5. Increased susceptibility to infection.

Xerophthalmia.—Bloch studied the incidence of xerophthalmia in children in Copenhagen over a number of years, and proved that most of the cases were due to vitamin A deficiency.

He says that the eye disease showed every stage of severity from xerosis of conjunctiva to hardening of the cornea leading to ulceration, necrosis, and even ultimate blindness. Local treatment of the eye condition in the ophthalmic department of the hospital gave little relief and no permanent improvement, but on supplying the patients with an adequate diet containing whole milk and *ol. morrhuae* the improvement was rapid.

A critical examination of 434 cases of keratomalacia in children and of nineteen cases in adults, which occurred in Denmark from 1909 till 1920, has shown that these were due chiefly to lack of vitamin A in the diet, and in the case of children to the increased requirement of this vitamin involved in rapid growth. The greatest number of cases occurred in winter and spring. This was attributed to the seasonal variation in the vitamin content of milk.

Night-blindness has also been shown by many European and foreign investigators to be due to vitamin A deficiency. Aykroyd, reporting on cases of night-blindness occurring in Newfoundland and Labrador, states that the Newfoundlanders themselves know how to treat the disease by fresh cod's liver or by cod-liver oil. Discussing the antiquity of treatment by liver, he points out that Hippocrates recommended that for night-blindness the patient should eat as large an ox-liver as possible, raw and dipped in honey.

Night-blindness has been stated to be due to a subnormal amount of visual purple in the retina.

Tissue Changes. — Hort, Miller, and McCollum in 1916 described changes in the anterior horn cells of the spinal cords of pigs caused by diet deficiency.

In 1926 E. Mellanby noted the production in dogs of a condition resembling combined sclerosis by the use of diets rich in cereals, especially in wheat-germ, and deficient in fat-soluble vitamins. In 1929 the same observer found that the experimental production of subacute combined degeneration of the cord could be hastened and intensified by adding a small quantity of ergot to the diet. The addition of vitamin A substances such as cod-liver oil or cabbages prevented the degeneration of the cord, or arrested its development if present.

It has been shown by McCarrison that in rats, renal and vesical calculi are produced when the diet has a low vitamin A content.

He also mentions that stone is commoner among wheat-eaters than among rice-eaters in India, and that whole wheat flour is much more productive of calculi in rats than rice flour.

Increased Susceptibility to Infection. — Green and Mellanby in 1928 reported the results of experiments on rats.

In ninety-four rats fed on a diet deficient in vitamin A they found the following percentages of infection:—

Xerophthalmia, thirty-eight per cent.; abscess at base of tongue, seventy-two per cent.; infection of lungs, nine per cent.; infection of genito-urinary tract, including renal and vesical calculi, forty-four per cent.; septic middle ear and nasal sinuses, twenty per cent.

In fifty control rats on the same diet with the addition of some source of vitamin A, there was no evidence of any septic infection.

It is still doubtful whether the administration of vitamin A is really of direct benefit in the treatment of bacterial infections in man. It is probable that animals deprived of vitamin A have less vitality and resistance to infection than animals with adequate nourishment.

Animal organisms possess the property of storing reserves of vitamin A which have been obtained directly or indirectly from vegetable sources. The amounts of vitamin present in the tissues will depend therefore not only on the power of the tissues to store the vitamin, but also on the previous dietary. The reserve amounts in the tissues of a grass-fed animal are much higher than in those of a stall-fed animal. This is important in considering the vitamin A content of milk and butter.

Most of the reserve is contained in the liver. The liver fats of grass-fed animals, such as the sheep and ox, are among the richest sources of vitamin A known.

VITAMIN D, THE ANTI-RACHITIC CALCIFYING VITAMIN.

This is a fat-soluble substance having the specific function of controlling the deposition of calcium and phosphorus in the tissues.

As bones and teeth are largely composed of calcium phosphate, it is obvious that the structure of these tissues is largely determined by the adequacy of the supply of vitamin D to the body during the period of their active development.

The extent of defective bone formation as seen in the great prevalence of rickets in the temperate zone, the widespread defect in the structure of teeth and the high incidence of dental caries, suggest that a deficient intake of vitamin D may be the most

important dietetic defect at present known.

About 1922 it was discovered that if a diet deficient in vitamin D were exposed to irradiation it acquired the property of preventing rickets. Later, in 1924, it was found that various foodstuffs, incapable in themselves of preventing or curing rickets, became endowed with anti-rachitic power after exposure to ultra-violet rays, and it was further shown that the foodstuffs which possessed this property were the fats.

These researches explained the effects of both sunlight and diet in preventing rickets; sunlight, by its action on the skin, generating vitamin D from cholesterol, and diet, by its containing adequate amounts of vitamin D.

It is probable that vitamin D is produced in the skin itself, or in the blood circulating immediately below the surface of the skin, by the activation of a precursor already present, probably cholesterol. The light waves which exert this action are confined to that part of the spectrum having wave-lengths of three hundred mille-microns or lower. This accounts for the negative effect of sunlight which is filtered through glass, as ordinary glass is opaque to these radiations.

It has been shown that dark-skinned races require more exposure to sunlight to generate vitamin D than white people. This accounts for the greater susceptibility of negro children to rickets when living in northern climates.

The only natural foods which are known to be rich in vitamin D are egg- yolk, cod-liver oil and other similar fish-liver oils. Cream and butter contain small amounts. Fresh vegetables, fruit, and meat have no apparent anti-rachitic effect on laboratory animals, and cereals may actually favour the development of rickets.

The anti-rachitic potency of cow's milk is a variable quantity depending on the environment and diet of the cow. In summer, when the cows are in the fields and exposed to sunlight, the content is much higher than in winter. The vitamin D content can be increased by including cod-liver oil or irradiated yeast in the animals' diet.

Milk is at no time a rich source of the vitamin; skim milk contains mere traces.

Children who, on account of poverty, cannot be supplied with adequate amounts of dairy produce, including eggs, and who consume vegetable fat in the form of margarine, are obviously liable to suffer from a defect of this vitamin unless its supply is assured in some special way, as by administering cod-liver oil or by exposure to natural or artificial ultra-violet radiation. Light and diet should be regarded as factors which supplement each other in the supply of vitamin D. Where there is much sunshine, less is required in the diet, but in the polar regions where the sunlight is less intense and the body more completely clothed, the function of protection passes from the light to the diet.

If the Eskimos who, on their natural diet of meat, fish, and oil, are healthy and have good teeth, change to civilized diet while living in the same latitudes, the health deteriorates, teeth decay, and the children develop rickets.

In Britain at the present day the adaptation of diet to climate is incomplete. Osteomalacia is rare, but bad teeth are almost universal and rickets is a common disease.

Experiments were carried out in Vienna in 1922 and 1923 by Chick and others on the relation between vitamin D and sunlight. Observations were made upon young infants receiving two types of diet.

Diet No. 1 consisted of undiluted milk with added sugar; diet No. 2 consisted of full cream, dried milk, and cod-liver oil.

Between May and October no case of rickets developed among a total of forty-two infants. Between November and April, thirteen out of fifty-one developed rickets; all these occurred among the twenty-five infants on diet No. 1.

During the summer the infants spent a great part of their time out of doors in the sun. Further observations showed that active rickets could be cured in the summer by exposure to sunlight, no matter what diet they were receiving. In winter rickets could be cured by diet No. 2, but progressed on diet No. 1.

The outbreak of osteomalacia which occurred in Vienna as a sequel of the Great War shows clearly that in winter we depend on our diet for the provision of this vitamin. It is quite certain that famine was the cause of the disease in Vienna. It was truly called hunger-osteomalacia, but it was equally truly cured by summer sunshine, and could have been cured by ultra-violet radiation from an artificial source.

Thus, while failure of diet was the cause of the disease in Vienna, the custom of *purdah* is the factor which determines the development of osteomalacia in India. *Purdah* confines women to the house and prevents their exposure to sunlight. For the same reason the disease is very common in parts of China. In these countries men on the same diet are not affected.

A study of ancient skeletons suggests that osteomalacia, which through the deformities caused

in the pelvis has a crippling effect on reproduction, was the cause of the extinction, about the end of the fifteenth century, of the Norse colony founded in A.D. 985 by Eric the Red in Greenland. This prevalence of osteomalacia was probablv due to failure to adapt the diet so as to supplement the lack of ultraviolet rays from the sun in these high latitudes.

A deficiency of calcium or phosphorus, or a faulty balance of these elements, in a diet containing inadequate amounts of vitamin D, will intensify the rickets-producing effects of the diet.

Relation to Cereals. – Where vitamin D is deficient, rickets develops more strongly in those animals which eat more cereals.

Of the cereals studied, oatmeal produced more severe rickets than maize, barley, or rice. Wheat-flour interfered less with bone calcification. (Mellanby : experimental work on puppies, 1922-5.)

Oatmeal contains plenty of calcium and phosphorus, so the effect cannot be due to deficiency of these elements. This occurs only when vitamin D is deficient.

Mellanby also showed that if the mothers receive an adequate supply of vitamin D during pregnancy and lactation, their offspring are much more resistant to rickets than puppies whose mothers have received no cod-liver oil during pregnancy.

Premature children are notoriously liable to develop rickets, and it is believed that the normal infant receives from its mother during the last few weeks of pregnancy important stores of vitamin D which help to protect it from rickets during its post-natal career.

Relation of Vitamin D to the Parathyroids. – The effect of the parathyroid secretion is apparently to maintain or raise the calcium and phosphorus excretion at the expense of the bones, while vitamin D brings about the incorporation of calcium and phosphorus in the bones, so that their actions are in opposite directions.

In tetany, which is frequently associated with rickets in infancy, vitamin D seems to raise to normal the blood-calcium by increasing the retention in the body of calcium present in the food. Parathyroid raises the blood-calcium by withdrawing it from the bones.

Briefly, in treating rickets, tetany, and osteomalacia, it is important to supply plenty of vitamin D and to cut down the cereals. Green vegetables also are useful. In addition, when possible the available sunshine should be used, or artificial sources of ultra-violet radiation employed.

VITAMINS AND DENTAL TISSUES.

Two types of dental defect are commonly found in civilized man: 1, Dental caries; 2, periodontal disease, including pyorrhoea alveolaris. The first of these concerns the tooth itself. The second involves the soft structures adjacent to the tooth and also the hard alveolar bone.

Vitamin D is concerned with the structure of the teeth and of the alveolar bone.

Vitamin A is concerned with the structure of the marginal epithelium of the gums.

The important investigations carried out by Mrs. Mellanby, 1918 till 1930, have definitely proved the importance of vitamin D as a factor in the normal development of the teeth and jaws. If the teeth are badly formed, and the dentine and enamel deficient, caries tends to develop at an early age.

Young puppies fed on a diet deficient in vitamin D showed the following defects in the development of the teeth and jaws:–

1. Delay in eruption of the permanent teeth.
2. Thickening of the jaw-bones and irregularity in the arrangement of the teeth.
3. Irregularly formed and poorly calcified enamel, the surface of which is pitted and grooved and frequently pigmented.
4. Defective development and irregular calcification of the dentine.
5. Abnormal development of the calcified tissues at the gingival margin, and hence irregularity of the periodontal membrane.

When an adequate supply of cod-liver oil was given, the surface was smooth, white, and shiny, and much thicker layers of enamel and dentine were produced, the dentine exhibiting a perfectly uniform structure with complete absence of interglobular spaces.

VITAMIN E.

It is only within the last fifteen years that the existence of a specific vitamin essential for reproduction, at any rate in the case of rats and mice, has been established. The view previously held was that a diet which would satisfy the animal's needs for growth and health would also be adequate for reproduction.

In 1920 Mattell and Conklin found that rats reared on whole milk, though growing well and appearing in good health, were usually sterile.

In 1922 Evans and Scott found that rats receiving a diet containing adequate amounts of protein, salts, and all the known vitamins were partially sterile in the first generation and wholly so in the second generation. This sterility was corrected by

an unknown substance X present in certain natural foods, such as fresh lettuce leaves, wheat embryo, and dried alfalfa.

In 1923 Evans and Bishop showed that the X factor was fat soluble and not identical with any of the known vitamins.

Sure, working independently, had come to the same conclusion, and suggested that this factor should be named vitamin E.

In 1927 Evans and Burr stated that in male rats and mice deprivation of vitamin E led to complete and incurable sterility in eighty-five to one hundred and fifty days, and that this was due to degeneration of the testes.

The richest natural sources of vitamin E are green leaves and the embryo of seeds. It is also present in animal tissues, especially muscle and fat, and to a lesser extent in milk and butter.

This work is being studied in relation to stock-breeding, by giving intramuscular injections of wheat-germ oil, and successful results have been reported in sterile cows. A number of workers are also investigating the part played by vitamin E in cases of human sterility. In these cases wheat-germ oil has also been used with success in some instances.

VITAMIN B COMPLEX.

In 1915 McCollum and Davis reported that young rats fed on a purified synthetic diet, containing butter fat to supply the fat-soluble vitamins already discovered by them in 1913, required for normal growth an additional factor, which in 1916 was named water-soluble vitamin B. This was considered by McCollum and his co-workers to be identical with the anti-neuritic vitamin discovered by Eijkman in 1897.

The fact that the distribution and properties of the water-soluble B factor, as ascertained by experiments on rats, closely agreed with those of the anti-neuritic factor established by experiments on pigeons, coupled with the similarity of the symptoms exhibited by rats and pigeons suffering from deficiency of this factor, led to the supposition that these substances were identical. Later it was found that the rat needed for normal growth two water-soluble vitamins – B_1 and B_2 – both of which were contained in vitamin B. (B_1 – the heat labile anti-neuritic vitamin discovered by Eijkman in 1897; B_2 – more heat stable, the pellagra preventive factor discovered by Goldberger and others in 1926, and necessary to prevent dermatitis in rats.)

Further research has shown that there are other factors present in the B complex, and that all of these are present in fresh yeast.

Vitamin B_1, the Anti-neuritic or Beri-Beri Preventive vitamin. – Beri-beri occurs principally among rice-eating populations in Japan, India, Malay Peninsula, Dutch East Indies, and the Philippine Islands. It is also endemic in Labrador and Newfoundland, where the inhabitants subsist largely on a diet of white wheaten flour.

In one case an outbreak amongst the laboratory fowl in Batavia was found to be due to the use, by the laboratory assistant, of boiled rice from the hospital kitchen for feeding the fowl. The disease lasted five months, and disappeared when a new chef was appointed who refused to supply the good military rice for fowl which were under the civil administration of the laboratory.

McCarrison pointed out that the milling of rice is not the sole cause of beri-beri, as long before the introduction of machine milling beri-beri was endemic in India.

He believes that the supplemental foods in a diet are important in determining the development of this disease whatever may be the kind of rice consumed.

Outbreaks of beri-beri are not common among wheat-eating populations, as people who eat white wheaten bread generally belong to the more highly civilized and richer countries where the diet is more varied and this vitamin is obtained from other sources.

In Newfoundland and Labrador the population subsists largely on bread during the winter and spring. Formerly when the bread was baked from brown flour, beri-beri was unknown, but later when pure white wheaten flour was introduced, beri-beri became common.

Beri-beri was rare in Norwegian ships prior to 1894. In that year improvements were instituted in the diet supplied to the sailors; one of these was that bread was to be baked from white wheaten flour instead of from rye flour. After this beri-beri frequently occurred in these ships.

Beri-beri also occurred among our troops in the Dardanelles and in Mesopotamia during the Great War, due to the consumption of white wheaten bread and to the absence of a suitable mixed diet; as a supplement to the bread, chiefly canned and preserved foods were being used.

In Mesopotamia the disease was confined to the British troops, and did not occur among the Indian soldiers. The reason for this was that the latter received *atta*, a coarsely-ground whole-wheat flour, and also a daily ration of dried pulses of various kinds which are rich in anti-beri-beri vitamin.

During the siege of Kut-el-Amara in 1910, beri-beri appeared early among the British troops, but later ceased when the white flour was finished and the troops received part of their flour ration in the form of barley-flour or *atta.* The Indian troops were not affected.

During the latter half of the siege the Indian troops suffered greatly from scurvy, while the British troops were not affected. The diet of the former was largely cereal, while the latter were protected by a large ration of meat, including horse-flesh. They consumed from eight to twenty ounces daily, and this apparently protected them from scurvy. No fresh vegetables were available.

Vitamin B_2, the Anti-dermatitis Vitamin or Anti-pellagra Vitamin (Vitamin G of some American writers). — Sufferers from pellagra get dermatitis on the face and hands and on those parts of the body exposed to sunlight, accompanied by disorders of the digestive system, and later by lesions in the nervous system with mental symptoms.

Pellagra was first described by the Spaniard Casal in 1735. Some time later it was recognized, and received its name, in Italy, where it has since been prevalent.

Early in the nineteenth century it was observed in France, and subsequently spread eastward across Europe to Hungary, Roumania, Turkey, and Greece.

In the United States pellagra first became seriously evident about 1909. In 1917, 170,000 cases were recorded among the negroes and poor whites in the southern states, with a high mortality.

Before the germ theory of disease became established (and fashionable) as the cause of certain diseases, many physicians recognized that pellagra and beri-beri were due to dietary deficiencies, but when the bacterial origin of disease was established by Pasteur, it was believed that these diseases must also be due to microbic infection.

Between 1843 and I866 the French physician Roussel pointed out the very important fact that the history of the spread of pellagra in Europe is the history of the introduction of maize as a staple food.

Brought from America, maize reached first Spain, then France, and thence its use spread gradually eastward, and pellagra followed it across Europe into Africa.

At one time it was believed that pellagra was due to a poison contained in maize. Cases have been reported among people on other diets — rice, millet and wheat-flour. These are exceptional, and pellagra should be regarded as almost exclusively a maize-eaters' disease.

It was found that the addition of meat and milk to the diet prevented and cured pellagra, and later in 1926 the value of yeast as preventive factor was proved by Goldberger and Tanner, who accidentally discovered that yeast was effective in preventing experimental black-tongue in dogs — a condition similar to pellagra in man.

Subsequently Goldberger and his colleagues were able to identify the pellagra-preventive factor with a vitamin contained in yeast, and differing from the anti-neuritis vitamin in its stability to heat and in its distribution in foodstuffs. This is now definitely known as vitamin B_2.

VITAMIN C, THE ANTI-SCORBUTIC VITAMIN.

Scurvy has for many centuries been regarded as a disease due to dietetic deficiency. It was common knowledge in olden times among seafaring folk that scurvy occurred after deprivation, for long periods, of fresh foodstuffs, and that it could be prevented and cured by the use of fresh vegetables and fruits.

Lind in 1757 published "A Treatise on the Scurvy." In this he states: "On the 20th May, 1747, I took twelve patients in the scurvy on board the "Salisbury" at sea. Their cases were as similar as I could have them. They all in general had putrid gums, the spots, and lassitude, with weakness of their knees. They lay together in one place, being a proper apartment for the sick in the forehold, and had one diet common to all, viz., water-gruel sweetened with sugar in the morning, fresh mutton broth oftentimes for dinner, at other times light puddings; boiled biscuits with sugar, etc., and for the supper barley and raisins, rice and currants, sago and wine or the like.

"Two of them were ordered each a quart of cyder a day. Two others took twenty-five drops of elixir vitriol three times a day on an empty stomach, using a gargle strongly acidulated with it for their mouths. Two others took two spoonfuls of vinegar three times a day upon an empty stomach, having their gruels and their other food well acidulated with it, as also the gargle for their mouths. Two of the worst patients, with the tendons under the ham rigid (a symptom none of the rest had), were put under a course of sea-water. Of this they drank half a pint every day, and sometimes more or less, as it operated by way of a gentle physic. Two others had each two oranges and one lemon given them each day. These they ate with greediness at different times upon an empty stomach. They continued but six days under this course, having consumed the quantity that could be spared. The two remaining patients took the bigness of a nutmeg three times a day of an electary

recommended by a hospital surgeon, made of garlic, mustard seed, rad. raphan, balsam of Peru, and gum myrhh, using for common drink barley-water well acidulated by tamarinds, by a decoction of which with the addition of cremor tartar they were gently purged three or four times during the course.

"The consequence was that the most sudden and visible good effects were perceived from the use of oranges and lemons, one of those that had taken them being at the end of six days fit for duty. The spots were not indeed quite off his body, nor his gums sound, but without any other medicine than a gargarism of elixir vitriol, he became quite healthy before we came into Plymouth, which was on the 16th June.

"The other was the best recovered of any in his condition, and being now pretty well, was appointed nurse to the rest of the sick.

"Next to the oranges, I thought that the cyder had the best effects. It was, indeed, not very sound, being inclined to be aigre or pricked. However, those who had taken it were, in a fairer way of recovery than the others. The putrefaction of the gums, but especially their lassitude and weakness, were somewhat abated, and their appetite increased by it.

"As to the elixir vitriol, I observed that the mouths of those who had used it by way of gargarism were in much cleaner and better condition than any of the rest, especially those who used the vinegar, but perceived otherwise no good effects from its internal use upon the symptoms.

"There was no remarkable alteration upon those who took the electary and tamarind decoction, the sea-water, or vinegar, upon comparing the condition at the end of the fortnight with others who had taken nothing but a little lenitive electary, and cremor tartar at times in order to keep their belly open, or a gentle pectoral in the evening for the relief of their breast."

Apparently the anti-scorbutic factor is found in nature, associated primarily with living plant tissues in which the active metabolic processes are still proceeding. When the active processes cease or are greatly reduced, as in seeds, this vitamin disappears. In the case of seeds it is created anew during germination.

Although present in the animal body in muscle, it does not appear to be stored there to the same extent as vitamin A, and it has been shown by experiments on guinea-pigs that previous administration of large amounts of vitamin C to the animals does not increase the time necessary for the development of scurvy.

VITAMINS AND HUMAN DIETS.

So far as this country is concerned, the rareness of well-marked deficiency diseases such as pellagra, beri-beri, xerophthalmia, and scurvy indicates that an absolute deficiency of vitamins rarely exists in the individual diet, but it is probable that much sub-normal health, under-development, and liability to infection may be associated with a partial deficiency of one or more of the vitamins. The influence of these deficiencies may be serious when they occur in early life, and judging from animal experiments an adequate supply of these vitamins in later life may fail to make good the damage caused by deficiency in infancy and childhood. There is also a danger that partial or latent deficiency may persist as a chronic condition in adult life, as many diets are deficient in vitamin supply, especially among the poor. Cereals are said to form sixty per cent. of the total food consumed in this country, and in the diet of the poor this percentage is higher on account of the relative cheapness of cereals. Cereal food, although it provides sufficient energy, is almost devoid of vitamins A, C, and D, and has been shown to have an antagonizing action on vitamin D.

In planning restricted diets which may require to be taken for prolonged periods, sight should never be lost of the vitamin content of the diet. This applies especially to the dietary of patients suffering from gastric and duodenal ulcers, colitis, diabetes, and nephritis, when patients are frequently kept for a long time on a totally inadequate diet as regards vitamins. In many cases, as a result of this, they become anaemic and debilitated, their resistance is lowered, and their power of recovery is lessened. The same difficulty occurs commonly in the case of children, who are frequently capricious and faddy about their food, and refuse to take certain articles of diet containing vitamins which are absolutely essential for their proper development.

In such cases it is the duty of the physician to secure the provision of these factors from other sources, including the artificially prepared substitutes which are now available.

[A Table of the Vitamin Content of the More Common Foodstuffs then followed which has not been reproduced here.]