

The  
Relations of  
Vitamines to Disease

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THE Vitamines theory of food deficiency diseases was enunciated by Funk in 1911 (1). He noted that polyneuritis developed in animals when they were fed on a diet of polished rice; and that these animals rapidly recovered when whole rice was substituted for the polished, and to the unknown substance contained in the husk of the rice he gave the name vitamines. He believed that beriberi, which is analagous to the experimental polyneuritis, scurvy, rickets and pellagra were due to a food deficient in vitamines and to them he gave the name "Deficiency Diseases." (2)

Objections (3) have been raised to the term vitamines, for there are many other substances in food that are as vital to growth and health as vitamines, *e.g.*, the amino acids. Again, all amines contain nitrogen but not the vitamines known as fat-soluble A. However it is a concise term and will probably be retained for some considerable time.

The term, accessory factor, was introduced by Hopkins (4), but other substances, condiments for example, might thus be included. By accessory factor we infer that vitamines are not so essential to health or growth as other food substances. We can maintain health without fats or carbohydrates but we must have the antiscorbutic, the antiberiberic factor, etc. From this point of view, vitamines are the essentials while fats and carbohydrates are more truly accessory.

The term Growth Determinants, does not take cognizance of the fact that these substances are as necessary for the adult as for the growing animal.

The term, Food Hormones, was suggested because it was thought that vitamines produced their effects in a manner analagous to hormones. The small amount necessary to produce marked changes in nutrition is one point vitamines have in common with hormones. For example take thyroxin, the hormone of the thyroid gland. Kandall (5) estimates that one-third milligram will increase basal metabolism one per cent. in a myxedematous patient weighing 150 pounds.

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The terms, fat-soluble A and water soluble B, have been suggested by McCollum and Kennedy (6) and have few objectionable features. A diet deficient in fat soluble A(7) produces in animals xerophthalmia, a disease characterized by dryness of the eye, keratitis and blindness. An analogous condition has been observed in man. The presence of water-soluble B in a diet prevents the development of polyneuritis in experimental animals, and beriberi in man. Fat-soluble A is contained in butter fat and cod liver oil, in the yolks of eggs and the leaves of vegetables. Water-soluble B is found in milk and fresh vegetables.

Eijkman (8) as early as 1897 compared the prevalence of beriberi among the prisoners in the gaols of the Dutch East Indies. He divided the total number (more than one quarter of a million of men) into aliquot groups of 10,000. He found that in each group of 10,000 eating polished rice there were 3,900 cases of beriberi and that in each group of 10,000 eating the unpolished rice there was but one case. These statistics proved conclusively that beriberi is caused by a diet of polished rice. Several years later, Funk demonstrated that polished rice lacks vitamins which are found in the outer covering of the rice grains. In Canada, beriberi is practically unknown but it might be suggested that neurasthenia, neuralgia and chronic nutritional diseases have as a complication a subacute type of this disease and that part of the benefit of the Weir Mitchell treatment can be explained on the assumption that the full diet, in which milk and eggs predominate, supplies the necessary vitamins.

McCollum (7) states that xerophthalmia and beriberi are the only true deficiency diseases in the sense in which Funk and his school employed this term. Nevertheless in this paper we shall briefly discuss scurvy, rickets and pellagra.

Scurvy has been known since the days of the Crusaders. The barbers of those early days were the surgeons and one of their duties was to trim the gums of patients suffering from scurvy.

Jacques Cartier (9) gives a very accurate description of the disease which was very prevalent among his sailors while at Quebec during the winter of 1536-37. He says, "The mouth became so infected and rotten at the gums that all the flesh fell off even to the roots of the teeth, so that the teeth nearly all fell out." The bark and leaves of a tree called Ameda were boiled and cured the disease in a few days.

Captain Cook (10) in his second voyage to Australia in 1773 had a similar experience when the diet was limited to biscuits and salt meat. The sailors "who were incapable of moving without assistance, were in

the compass of a few days able to walk about of themselves when they were given 'wort,' marmalade and rob of lemons and oranges." (11)

An interesting report showing the value of fresh beer as a cure for scurvy comes from Norway. Among the men of a certain sailing vessel scurvy appeared and the captain put into port and left his patients there while he proceeded further down the coast for fresh vegetables. Some of the men secured a supply of fresh beer and rapidly recovered while their less fortunate comrades had to await the arrival of fresh vegetables.

Scurvy existed among the troops of the various armies during the recent war, least of all among the men along the Western front. Severe outbreaks occurred in Mesopotamia (12) and Serbia. The investigators at the Lister Institute only late in the war learned the value of germinated seeds, *e.g.* peas and beans, in the cure of scurvy. Acting on this suggestion (13), Major H. W. Wiltshire (14) made some interesting observations in treatment of scurvy in Serbian soldiers. Beans were allowed to germinate for 48 hours and then ten minutes boiling was ample time to fit the beans for eating. He reported that seventy per cent. were cured within four weeks with germinated beans as opposed to fifty-three per cent. treated with lemon juice. Captain Cook had used this method over 200 years before. He took with him malt which on germination produced fresh beer which formed a very agreeable cure for the disease.

Hess (15), in his investigation of scurvy in children, noticed that pasteurized milk, milk with high fat content, buttermilk with no fat, protein milk or proprietary foods would not produce the disease with regularity and so concluded that scurvy was not a deficiency disease as defined by Funk. The primary disturbance is a faulty diet which favors a secondary infection (16). Milk is only mildly antiscorbutic: it has been estimated that an infant requires at least one pint of fresh, raw milk daily to protect it from scurvy. If pasteurized, stale or heated milk is used, more than one pint will be needed. Since milk contains fat-soluble A and water-soluble B, we can readily understand what Mrs. Rose (17) intended to emphasize by this fanciful comment, "When the milk pitcher is allowed to work its magic for the human race, we shall have citizens of better physique than the records of our recruiting stations show to-day. Even when the family table is deprived of its familiar wheat bread and meat we may be strong if we invoke the aid of this friendly magician." Milk has a high calcium content and a considerable amount of sodium chloride, two of the most important mineral elements in the body. The universal practice of salting food, the craving of animals for salt and the drinking of water rich in calcium indicates the important role these chemicals play in human economy.

When we remember that it usually requires about six months before a case of scurvy reaches a phase where it can be recognized clinically, it is clear that the great majority of cases must be latent and inaccessible to diagnosis by clinical or laboratory methods. It is therefore more and more necessary that antiscorbutics should be added early to the diet of the bottle fed infant. Canned tomato (18) has recently been advocated and has the advantage over orange juice in that it is inexpensive and available at all times of the year. Cabbage, onions, and turnips are other sources of antiscorbutics.

Studies of rickets have convinced some investigators that this, too, is not a deficiency disease, since many cases have developed among breast fed infants. Rickets is perhaps the most common disease in children caused by a defective diet. In the larger cities, especially among the foreign population (19), rickets in infants is the rule rather than the exception. The lack of fat-soluble A in the diet has been regarded as the cause of this disease. Dogs (20) can be fed on a diet in which vegetable oils supply the fat, and scurvy readily develops. It is easy to prevent this by substituting butter fat for the vegetable oils. The inorganic salts, especially calcium and phosphorus, are regarded by other investigators as important etiological factors (21). A defective diet favors infections and this may be regarded as part of the diseased condition.

Pellagra, according to Goldberger (22), is caused by a diet, deficient in fat-soluble A, water-soluble B, a defective mineral supply, and perhaps inadequate supply of animal protein foods. Pellagra, although fairly common in the Southern States, is unusual in Canada. A few cases have been reported in the Asylum service.

McCollum (23) is satisfied that with the diets employed in Europe and America there is no such thing as a vitamine problem other than that of securing an adequate amount of the substance fat-soluble A. In planning a balanced diet there should be included the proper proportion of the essential constituents, fats, carbohydrates, proteins, inorganic salts, and vitamins or fat-soluble A and water-soluble B. Without these indispensable elements, the animal cell is unable to maintain its activities unimpaired or the adolescent subject to attain normal growth. Continued deprivation leads to disease and ultimately to cessation of life. The great war has taught us that appetite is by no means so safe a guide for the adequate selection of foods as has generally been supposed. The soldier brought with him to the mess an appetite trained in likes and dislikes, with local prejudices for or against certain articles of diet, and it was impossible to coax or coerce him in accepting a diet, which scientific studies deemed best for him.

#### SUMMARY.

1. Xerophthalmia and beriberi are two deficiency diseases in the sense in which Funk and his co-workers employed this term.

2. Scurvy, rickets and pellagra are caused by diets which are faulty and which favor secondary infections.

3. A diet of carbohydrates and fats, protein and inorganic salts of ample calories may still be a dangerously deficient diet.

4. Appetite is by no means as safe a guide for the proper selection of foods as has generally been supposed.

5. Latent and mild cases of beriberi, scurvy, rickets or pellagra are even more common than suspected, associated with chronic nervous conditions, characterized by malnutrition.

6. Antiscorbutics, *e.g.* orange juice or tomatoes, should be added early to the diet of the infant.

7. The more liberal use of protective foods, milk and the leafy vegetables should be advocated.

8. Inadequate diet favors infection, *e.g.* tuberculosis, scurvy, rickets, pellagra.

In conclusion, it seems that we, as Canadians, should earnestly consider the advantages of a nutritional laboratory where many problems of national importance would be investigated. The admirable work of the Carnegie Nutritional laboratory of Boston and of the Lister Institute of London should stimulate a more thorough study of the many problems of nutrition. The Inter Allied Scientific Food Commission decided to recommend that France, Italy, England and the United States establish laboratories for the study of human nutrition. The Commission called attention to the fact that at least one quarter of the income of a nation is devoted to the purchase of food by its individual citizens, and that since the poorer the individual, the greater is the proportion of his wage devoted to the purchase of food, it is therefore a matter of highest importance for the welfare and prosperity of a nation that the methods of the best possible utilization of its food resources be sought out and in time definitely established by reliable scientific data.

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