

fundamental concepts of this theory are correct. We must not forget, however, that we have restricted our considerations to distances of the order of magnitude $1/\lambda$. Little can be said at present about the contributions of smaller distances. All we can say is that their contributions to the effects considered are at most of the same order of magnitude as those from greater distances. Our results are largely independent of the particular formalism chosen to describe the meson field, so long as it conforms with what we had to postulate. Many important details, however, do depend on the value chosen for the spin of the meson (0 or 1, or both); for example the order of the levels in the deuteron, and the behaviour of the meson during collisions with other particles and light quanta. In some cases more or less serious difficulties arise if the theory is applied to distances smaller than $1/\lambda$. In this respect no definite decision has been reached yet, and we must expect further information from future developments.

Finally, we must also mention the β -decay of the meson. This was originally a second idea of Yukawa's, quite independent of his theory of the nucleus. It was assumed that the meson can decay directly into an electron and a neutrino. The decay of the meson has since been confirmed experimentally. The great advantage of this hypothesis is that it reduces the β -decay to a much simpler form. Whereas a nucleus decays emitting the electron into a continuous range of energy, the electron emitted by a free meson can only have the energy $\mu c^2/2$ (leaving the other half for the neutrino). The β -decay of a nucleus then takes place by means of an intermediate emission of a meson but the fundamental process underlying the β -decay of a nucleus is the decay of the meson. It is clear that a detailed study of the meson decay will give us very valuable information about the most important problem of the existence of the neutrino. A detailed discussion, however, lies outside the scope of this article.

BIOLOGICAL ACTION OF VITAMINS

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SOME of the outstanding developments in vitamin research reported in the symposium on the "Biological Action of Vitamins", held at the University of Chicago as part of its fiftieth anniversary celebration during September 15-17, were:

(1) The further clarification of the functions of diphosphothiamin in carbohydrate metabolism by Mr. Severo Achoa, of Washington University, in St. Louis; (2) The separation of a new B vitamin, folic acid, a yeast growth stimulant announced by Mr. Roger J. Williams, of the University of Texas; (3) The proof of the identity of biotin, vitamin H, and co-enzyme R, presented by Mr. Vincent du Vigneaud of Cornell Medical College, New York City; (4) The isolation from egg white of avidin, a substance which combines with and thus inactivates biotin, also reported by Mr. Roger J. Williams; (5) The description of a new choline deficiency effect in young rats characterized by hæmorrhagic degeneration of the kidneys, described by Mr. Wendell H. Griffith, of St. Louis University, in St. Louis; (6) The description of the symptoms of human ariboflavinosis by Dr. W. H. Sebrell, of the United States Public Health Service; (7) The extension of vitamin therapy in human nutritional diseases, reported by Dr. Norman Joliffe, of New York University, by Dr. David L. Smith, of Duke University, and by

Dr. Tom Spies, of the University of Cincinnati; (8) The use of vitamin K to prevent bleeding in patients having a low prothrombin content in the blood, reported by Drs. Harry P. Smith and Emory D. Warner, of the University of Iowa.

Mr. Achoa, in his discussion of the functions of diphosphothiamin, pointed out that through its effect on the oxidation of pyruvic acid, diphosphothiamin may be expected to influence various phases of carbohydrate metabolism. This is true because of the fact that pyruvate oxidation causes the storage of a considerable amount of energy in the form of adenosine triphosphate. We may expect diphosphothiamin to be indirectly involved in the synthesis of glycogen from glucose and in the conversion of fructose to glucose, since these reactions are driven by the mobilization of the phosphate bond energy in adenosine triphosphate.

Mr. Achoa also suggested the possibility that diphosphothiamin may aid in the absorption of sugar from the intestines and in resorbing glucose in the kidney tubules. It also may be involved in the process of forming carbohydrate molecules from lactic acid or from pyruvic acid. This vitamin complex likewise hastens production by the body of acetylcholine, an agent involved in the neuromuscular mechanism.

Folic acid, so named because it is most abundant

in leaves, was discovered as an important factor in yeast nutrition. Its isolation was accomplished this year by Mr. Roger J. Williams and his co-workers, who report its presence in all animal tissues examined, as well as in leaves. The implication that it is involved in animal nutrition is obvious, although nothing is known as yet of its function in the higher organisms.

Mr. Williams also discussed the various bio-assay methods, using yeasts and bacteria which have been developed by his group for the quantitative estimation of the eight water-soluble B vitamins discovered to date: thiamin, riboflavin, nicotinic acid, pyridoxin, pantothenic acid, biotin, inositol and folic acid. These methods have proved highly satisfactory with respect to ease of manipulation and reproducibility of results.

Mr. Vincent du Vigneaud described the story of the steps by which three lines of research on vitamin H, the anti-egg-white injury factor, on biotin, one of the factors essential for yeast growth, and on co-enzyme R, which functions in the growth and respiration of many strains of legume nodule organisms—the Rhizobia—have converged to show that the three activities reside in one single substance.

In 1936 Kögl and Tönnes announced crystalline biotin. In 1939, West and Wilson suggested that biotin and co-enzyme R are probably identical. In 1940, György, Rose, Hofmann, Melville and du Vigneaud noted the similarity of the properties of vitamin H with those of co-enzyme R and biotin. They found that their vitamin H concentrates had parallel activity for the other two factors. A biotin methyl ester preparation contributed by Kögl had high vitamin H unitage. The du Vigneaud group then prepared biotin methyl ester from a vitamin H liver concentrate, and using this preparation confirmed the identity of biotin, co-enzyme R and vitamin H. Their product had a melting-point of 166°–167°, which is 18° higher than that reported by Kögl for his preparation. No explanation for this difference in melting-point has been found.

The structural formula of biotin has not been completely solved. It is probably a cyclic urea derivative with the composition $C_{10}H_{16}O_2N_2S$. By the action of barium hydroxide at 140° it forms a diaminocarboxylic acid, $C_9H_{14}O_2N_2S$. Biotin has been resynthesized from this diaminocarboxylic acid by treatment with phosgene.

Of interest in its relation to biotin was the reported isolation by Mr. R. J. Williams and his group of avidin from egg white. This is the substance which combines with and inactivates biotin, thus producing the so-called egg-white injury which develops when raw egg white is fed to rats and chicks.

The effect of choline deficiency on young rats was described by Mr. W. H. Griffith. Young rats on a low choline, low fat and low cholesterol diet exhibit an extremely toxic effect in which there is a marked hæmorrhagic enlargement and degeneration of the kidneys, a regression of the thymus and an enlargement of the spleen. The degeneration of the kidney particularly is very rapid, and may cause death in a ten-day period. The deficiency is prevented by amounts of choline too small to influence the deposition of liver fat. Supplements of cystine, fat or cholesterol increase the severity of the lesions; choline, methionine and betaine neutralize their toxic effects. Since cystine fat and cholesterol also increase the amount of fat in the livers of older rats, it appears that the hæmorrhagic degeneration and fatty livers are different manifestations of the same deficiency. The work of du Vigneaud and his co-workers proving that choline is involved in transfer of methyl groups indicates that the symptoms described are evidences of methyl deficiency. Griffith and his associates found that a creatine supplement lessens the severity of the lesions, but does not entirely prevent them. He suggested that while the methyl group of creatine is not available for choline synthesis, it may exercise a sparing action by making available for choline synthesis the methyl groups which would otherwise be used in the formation in the body of creatine.

As each vitamin has been made available in crystalline form, clinicians have studied its effect in the treatment of human subjects who present symptoms similar to those shown by animals that have been maintained on diets deficient in that specific vitamin. Dr. Joliffe discussed the use of thiamin for many types of polyneuritis frequently associated with alcoholism, pregnancy, gastrointestinal disturbances and pellagra, as well as for cardiovascular disturbances, œdema, anorexia, and many other symptoms which may be manifestations of a sub-acute deficiency. He emphasized the importance of finding a means to detect early and mild vitamin deficiencies.

The history of pellagra and the final discovery that nicotinic acid is a specific for its cure long after this vitamin had been isolated, found ineffective in curing beriberi, and discarded as of no nutritional value, was related by Dr. David T. Smith. He described in detail the symptoms of nicotinic acid deficiency and the methods of treatment.

One of the most striking clinical developments in the vitamin field during the past two years has been the recognition of riboflavin deficiency symptoms. These were described by Dr. Sebrell. Dr. Sebrell and his co-workers placed eighteen adult women on a riboflavin-deficient diet. The first symptom

observed was a pallor of the mucosa in the angles of the lip. A few days later superficial fissures developed exactly in the angle of the mouth. These lesions were covered with a honey-coloured crust which could be scraped off without causing bleeding. The lips became abnormally red and shiny, and the tongue a purplish red. In addition, a fine scaly desquamation appeared about the nose and ears. The ocular lesions were equally marked. The cornea appeared inflamed, due to its invasion by capillaries. This condition was followed by corneal opacity. Patients complained of itching and burning of the eyes, a hyper-sensitivity to light, and eye fatigue.

These symptoms comprise the clinical picture known as ariboflavinosis. Dr. Sebrell has found it very prevalent among people who are not economically restricted to a poor diet. In fact, he stated, without the inclusion of liberal amounts of milk, liver and eggs, it is difficult to select a diet adequate in riboflavin.

In the case of human subjects, clinical experience has demonstrated that vitamin deficiencies are usually mixed, rather than simple, and that the administration of all the vitamins together produces more rapid and complete cures than does treatment with any single vitamin. This phase of vitamin therapy was emphasized by Dr. Tom Spies. He reported a study of "twenty-five malnourished patients with mild pellagra, beriberi or riboflavin deficiency who were becoming worse in spite of bed rest and were refusing the diet offered them. They were given a mixture of brewers' yeast powder (25 per cent), peanut butter (67 per cent) and peanut oil (8 per cent). All except two patients ate it twice a day, and all of them improved gradually." Because such a mixture is a rich source of the natural vitamins of the B complex, as well as of protein, fat, carbohydrate and mineral salts, he suggested the popularization of a sandwich of whole wheat or high vitamin bread,

combined with this peanut butter - dried yeast spread as a most effective preventive or therapeutic measure.

The efficacy of vitamin K in preventing bleeding in patients with a low prothrombin concentration in the blood was reported by Drs. Harry Smith and Emory D. Warner. Hæmorrhages due to failure of the blood to clot occur in both mother and child at child-birth, in obstructive jaundice, in chronic intestinal disorders and in bile duct tumours. This failure to clot is due to the inability of the body to produce enough prothrombin. Vitamin K is an essential factor in the production of prothrombin. It is effective administered orally.

Drs. Smith and Warner recommended the inclusion of green vegetables, especially spinach, kale and tomatoes, in the diets of mothers during the last month of pregnancy, and the feeding of cow's milk to infants during the first three days of life to provide the necessary vitamin K during this critical period.

The most recently separated vitamins, pyridoxin and pantothenic acid, are already being studied clinically. Although a pyridoxin deficiency has not been described as a definite entity, the vitamin is believed to function in muscle metabolism. It was reported to cause improvement in patients having muscular weakness or suffering from Parkinson's disease. Here, again, administration with or after thiamin and nicotinic acid produces better results than when pyridoxin is given alone.

Pantothenic acid has been found in human blood. Dr. Edgar S. Gordon, of the University of Wisconsin, stated that very little is known as yet of its possible functions or of its clinical value. Spies and his co-workers found that the injection of pantothenic acid was followed by a rise in the riboflavin content of the blood. He believes that this vitamin is also essential in human nutrition, and that it is associated in its action with riboflavin.

LABOUR CONDITIONS IN WEST AFRICA

By F. W. H. MIGEOD

FOR countless centuries Africa had supplied labour to Eastern countries. When the American continent was discovered, an immediate demand arose for African labour for its plantations and industries. Eventually the slave trade came to an end, and Africa turned to developing the export of its own products, chiefly forestal. Progress after the change-over was slow at first. At the opening of the present century, however, mining was already well established, and planta-

tions were started to extend the growth of economic products and secure a higher standard of quality. There ensued an increasing demand for paid labour. Nevertheless, in West Africa, the collection and preparation of forest products was still carried on by the natives in their own villages, as it still is. They traded their loads at the nearest store, or the one that offered best terms, and what they received for it was shared out between the members of the family concerned.