been recommended as a more suitable name for nicotinic acid in commercial products.

Good food sources of this vitamin are liver, lean meat, and yeast. Fair sources are certain whole cereals, legumes, and wheat germ. Milled cereals, fats, and molasses are low in nicotinic acid. Several procedures have been suggested for assaying foodstuffs for their nicotinic acid content. Of these the most widely used are the dog assay based on the cure of black-tongue, a chemical method based on the development of a yellow color when an extract of the sample is treated with cyanogen bromide and aniline, and a bacterial method similar to the procedure described for riboflavin.

Requirements

Estimates of the amount of nicotinic acid (or its equivalent in the form of nicotinamide, or other related substances such as DPN and TPN) needed daily by various persons are summarized in Table 9–3. Notice how much larger amounts are required than in the case of other B vitamins. Quantities of representative foods which will probably supply 10 to 20 mg. of nicotinic acid are: 1 oz. dried yeast, 3 oz. pork liver, ½ lb. lean beef or pork, 4½ lb. spinach, or 5½ lb. tomatoes.

PANTOTHENIC ACID

Physiological function

The existence of pantothenic acid was first suggested by Williams and associates in 1933, as a result of their work on the stimulation of yeast growth by extracts of various biological materials. The active substance present has been found to be identical with the dietary factor that prevents chick dermatitis, a disease that was for a time thought to be analogous to pellagra in man.

When young chicks are placed on a ration deficient in this vitamin, crusty scabs form at the corners of the mouth and gradually enlarge until the skin around the nostrils and underneath the lower mandible is affected. Growth ceases and feathering is retarded. Death may result within two or three weeks after these symptoms become apparent. Administration of pure calcium pantothenate causes resumption of growth and disappearance of the dermatitis.

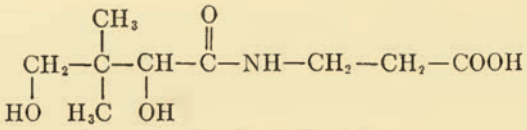
Rats, dogs, and swine have also been found to require this vitamin. The black portions of the fur of rats and foxes kept on diets low in pantothenic acid have been observed to turn gray. They have been found to regain their normal color when the vitamin was administered (Fig. 9–15, p. 255). Pantothenic acid has also been shown to be essential in the nutrition of a number of lower organisms, especially yeasts and lactic acid bacteria. There is fairly definite evidence also that panto-

thenic acid is involved in human nutrition, although clinical experience in this direction is still rather meager.

Pantothenic acid functions as part of a coenzyme (coenzyme *A* or *Co A*) in a system which brings about the condensation of acetic and oxalacetic acids to form citric acid, one of the steps of the citric acid cycle (p. 330). In fact *Co A* is probably needed for all metabolic reactions of the "two carbon fragment" (acetic acid or some closely related substance) produced during the oxidation of fats and carbohydrates in the body. Since this fragment is also used for the biological production of fats, steroids, acetyl choline, and probably many other products, the indispensable nature of pantothenic acid for living organisms is easily understandable.

Chemical nature

Pantothenic acid is a peptide-like compound composed of β-alanine united through an amide linkage to an hydroxy acid. The complete structural formula is:



Pantothenic acid, $C_9H_{17}O_5N$

The details of this formula were worked out in 1940, and the synthesis of the vitamin was also accomplished in the same year. The substance

Courtesy of Merck & Co., Inc.

Fig. 9–11. Pantothenic acid.