Nutritional Biochemistry of the Vitamins

SECOND EDITION

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The Vitamins

The vitamins are a disparate group of compounds; they have little in common either chemically or in their metabolic functions. Nutritionally, they form a cohesive group of organic compounds that are required in the diet in small amounts (micrograms or milligrams per day) for the maintenance of normal health and metabolic integrity. They are thus differentiated from the essential minerals and trace elements (which are inorganic) and from essential amino and fatty acids, which are required in larger amounts.

The discovery of the vitamins began with experiments performed by Hopkins at the beginning of the twentieth century; he fed rats on a defined diet providing the then known nutrients: fats, proteins, carbohydrates, and mineral salts. The animals failed to grow, but the addition of a small amount of milk to the diet both permitted the animals to maintain normal growth and restored growth to the animals that had previously been fed the defined diet. He suggested that milk contained one or more “accessory growth factors” – essential nutrients present in small amounts, because the addition of only a small amount of milk to the diet was sufficient to maintain normal growth and development.

The first of the accessory food factors to be isolated and identified was found to be chemically an amine; therefore, in 1912, Funk coined the term vitamine, from the Latin vita for “life” and amine, for the prominent chemical reactive group. Although subsequent accessory growth factors were not found to be amines, the name has been retained – with the loss of the final “-e” to avoid chemical confusion. The decision as to whether the word should correctly be pronounced “vitamin” or “veitamin” depends in large part on which system of Latin pronunciation one learned – the Oxford English Dictionary permits both.
During the first half of the twentieth century, vitamin deficiency diseases were common in developed and developing countries. At the beginning of the twenty-first century, they are generally rare, although vitamin A deficiency (Section 2.4) is a major public health problem throughout the developing world, and there is evidence of widespread subclinical deficiencies of vitamins B2 (Section 7.4) and B6 (Section 9.4). In addition, refugee and displaced populations (some 20 million people according to United Nations estimates in 2001) are at risk of multiple B vitamin deficiencies, because the cereal foods used in emergency rations are not usually fortified with micronutrients [Food and Agriculture Organization/World Health Organization (FAO/WHO, 2001)].

### 1.1 Definition and Nomenclature of the Vitamins

In addition to systematic chemical nomenclature, the vitamins have an apparently illogical system of accepted trivial names arising from the history of their discovery (Table 1.1). For several vitamins, a number of chemically related compounds show the same biological activity, because they are either converted to the same final active metabolite or have sufficient structural similarity to have the same activity.

Different chemical compounds that show the same biological activity are collectively known as vitamers. Where one or more compounds have biological activity, in addition to individual names there is also an approved generic descriptor to be used for all related compounds that show the same biological activity.

When it was realized that milk contained more than one accessory food factor, they were named A (which was lipid-soluble and found in the cream) and B (which was water-soluble and found in the whey). This division into fat- and water-soluble vitamins is still used, although there is little chemical or nutritional reason for this, apart from some similarities in dietary sources of fat-soluble or water-soluble vitamins. Water-soluble derivatives of vitamins A and K and fat-soluble derivatives of several of the B vitamins and vitamin C have been developed for therapeutic use and as food additives.

As the discovery of the vitamins progressed, it was realized that “Factor B” consisted of a number of chemically and physiologically distinct compounds. Before they were identified chemically, they were given a logical series of alphanumeric names: B1, B2, and so forth. As can be seen from Table 1.2, a number of compounds were assigned vitamin status, and were later shown either not to be vitamins, or to be compounds that had already been identified and given other names.