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Physiological aspects of vitamin bioavailability

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1.1 THE ROLE OF VITAMINS IN HUMAN NUTRITION

1.1.1 Introduction

Vitamins are a group of organic compounds which are essential in very small amounts for the normal functioning of the human body. They have widely varying chemical and physiological functions and are broadly distributed in natural food sources. Thirteen vitamins are recognized in human nutrition and these may be conveniently classified, according to their solubility, into two groups. The fat-soluble vitamins are represented by vitamins A, D, E and K; also included are the 50 or so carotenoids that possess varying degrees of vitamin A activity. The water-soluble vitamins comprise vitamin C and the members of the vitamin B group,
nearly thiamin (vitamin B₁), riboflavin (vitamin B₂), niacin, vitamin B₆, pantothenic acid, biotin, folate and vitamin B₁₂. This simple classification reflects to some extent the bioavailability of the vitamins, as the solubility affects their mode of intestinal absorption and their uptake by tissues. The solubility properties also have a direct bearing on the analytical methods employed in vitamin assays.

For many of the vitamins, biological activity is attributed to a number of structurally related compounds known as vitamers. The vitamers pertaining to a particular vitamin display, in most cases, similar qualitative biological properties to one another, but, because of subtle differences in their chemical structures, exhibit varying degrees of potency. Provitamins are vitamin precursors, i.e. naturally occurring substances which are not themselves vitamins, but which can be converted by normal body metabolism into vitamins.

It is often stated that vitamins cannot be produced in the body and must, therefore, be supplied in the diet. This statement is valid for some of the vitamins, but is not strictly true for others. For example, vitamin D can be formed in the skin upon adequate exposure to ultraviolet radiation; vitamin K is normally produced in sufficient amounts by intestinal bacteria; and niacin can be synthesized \textit{in vivo} from an amino acid precursor, tryptophan. With the possible exception of vitamins D and K, vitamins must be supplied by the diet because they cannot be produced in adequate amounts by the human body. Plants have the ability to synthesize most of the vitamins and serve as primary sources of these dietary essentials.

1.1.2 Nutritional vitamin deficiency

Several of the B-group vitamins serve as coenzymes for enzymes that function in the catabolism of foodstuffs to produce energy for the organism. A typical coenzyme consists of a protein (apoenzyme) to which is attached the vitamin. The vitamin portion of the coenzyme is usually responsible for the attachment of the enzyme to the substrate. If the specific vitamin is not available to form the coenzyme, the sequence of chemical changes in the metabolic process cannot proceed and the product whose change is blocked accumulates in the tissues: alternatively, metabolism is diverted to another pathway. For some B-group vitamins, deficiency results in a biochemical defect which is manifested as a disease with characteristic symptoms. Subclinical deficiency and marginal deficiency are synonymous terms used to describe conditions in individuals who are not clinically nutrient deficient, but who appear to be close to it. An alternative and perhaps better term proposed by Herbert (1990) is ‘early negative nutrient balance’, which is used when laboratory measurements indicate that an individual is losing more of a nutrient than is being absorbed.