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Nutrition, Life Cycle, and Lifestyle

The emergence of boron as nutritionally important throughout the life cycle

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Introduction

In 1997, it was predicted that boron would be identified as an element with practical nutritional or clinical importance by the year 2000.1 Research findings since that time indicating that boron is needed or beneficial for many of life processes including embryogenesis, bone growth and maintenance, immune function, psychomotor skills, and cognitive functions suggest that this prediction will become true. The surprising thing about this development is that only 20 y ago students in the biological and medical sciences were being taught that boron was essential for plants but not for animals. In fact, at the time the first report about the possible nutritional importance of boron appeared,2 boron was generally regarded as an element of only toxicologic concern, especially in the hospital setting. Now that the opinion about the nutritional importance of boron is changing, a question that has come to the fore is: Why wasn't this recognized sooner? A reasonable answer to that question is that boron apparently has a biochemical function that is very subtle. Moreover, this role apparently is one that allows optimal functioning of other nutrients or hormones and thus is overlooked as attention is directed toward altering the intake of the substance whose suboptimal metabolism is directly involved in a pathologic consequence (e.g., calcium supplementation to prevent bone loss).

In 1987, based on assorted bits of evidence, mainly from plants, it was suggested that boron, through an effect on the cell membrane, affected calcium metabolism and hormone action in higher forms of life.3 In 1991, additional findings from plants and animals were used to change this suggestion to the

hypothesis that boron has a role in cell-membrane function or stability such that it influences the response to hormone action, transmembrane signaling, or transmembrane movement of regulatory cations or anions.4 Testing of this hypothesis has been difficult. Nonetheless, many of the recent findings showing that boron is needed or beneficial throughout the life cycle support this hypothesis.

Section snippets

Boron in reproduction, embryo development, and maturation

Recent research has shown that boron is needed in the early stages of life; this includes the demonstration that the lack of boron adversely affects reproduction and embryo development in both the African clawed frog, *Xenopus laevis*, and the zebrafish. Studies with rats and mice suggest that low boron status may affect reproduction in mammals.

In the *Xenopus* model, dietary boron deprivation induced a marked increase in necrotic eggs and a high frequency of abnormal gastrulation.5 The abnormal

Boron in growth and development

Boron apparently has not been demonstrated to have a marked effect on the growth of animal models used to date. Boron was found to slightly but significantly increase the growth of embryonic trout in a dose-dependent manner.9 In rats and chicks, growth has been found to be affected in a noticeable fashion by dietary boron only when a nutritional stressor is present. For example, in the presence of marginal vitamin-D deficiency, boron-deprived chicks did not grow as well as boron-supplemented

Boron in the adult

If boron influences hormone action, transmembrane signaling, and/or membrane function or stability, it would be expected that the lack of boron in the diet would have a variety of consequences in adult higher animals. This expectation has not gone unfulfilled. Boron nutriture has been found to affect the metabolism or utilization of numerous other substances involved in life processes including

macrominerals such as calcium and magnesium, energy substrates such as triacylglycerols and glucose,

Future challenges in boron nutrition research

Boron is an element poised to become recognized as a nutrient clinically important for optimal function throughout the life cycle. This recognition will be made easier by the establishment of a clearly defined role for boron that explains the myriad of effects it has at physiologic intakes. Many research findings support the concept that boron has a role that affects the action or metabolism of other nutrients at the cell-membrane level. There are several possible mechanisms through which boron

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