

## Foreword

*An Evidence-based Approach to Vitamins and Minerals: Health Benefits and Intake Recommendations* by Dr. Jane Higdon and Dr. Victoria Drake provides a much needed source of authoritative information on the role of micronutrients in health promotion and in disease prevention and treatment. The book is especially important because of the potential health benefits of tuning up people's micronutrient metabolism, particularly those with inadequate diets, such as the many low-income and elderly people. A metabolic tune-up is likely to have enormous health benefits but is currently not being addressed adequately by the medical community.

Maximum health and life span require metabolic harmony. It is commonly thought that Americans' intake of the more than 40 essential micronutrients (vitamins, minerals, and other biochemicals that humans require) is adequate. Classic deficiency diseases such as scurvy, beriberi, pernicious anemia, and rickets are rare, but the evidence suggests that metabolic damage occurs at intake levels between the level causing acute micronutrient deficiency diseases and the recommended dietary allowances (RDAs). When one input in the metabolic network is inadequate, repercussions are felt on a large number of systems and can lead to degenerative disease. This may, for example, result in an increase in DNA damage (and possibly cancer), neuron decay (and possibly cognitive dysfunction), or mitochondrial decay (and possibly accelerated aging and degenerative diseases). The optimum amount of folate or zinc that is truly "required" is the amount that minimizes DNA damage and maximizes a healthy life span, which is higher than the amount to prevent acute disease. Vitamin and metabolite requirements of older people are likely to differ from those of younger people, but this issue has not been seriously examined. An optimal intake of micronutrients and metabolites will also vary with genetic constitution. A tune-up of micronutrient metabolism should give a marked increase in health at little cost. It is inexcusable that anyone in the world should have

an inadequate intake of a vitamin or mineral, at great cost to that person's health, when a year's supply of a daily multivitamin/multimineral pill as insurance against deficiencies costs less than a few packs of cigarettes. Low-income populations, in general, are the most likely to have poor diets and have the most to gain from multivitamin/multimineral supplementation. As Hippocrates said: "Leave your drugs in the chemist's pot if you can heal the patient with food."

Although many degenerative diseases will benefit from optimal nutrition, and optimal nutrition clearly involves more than adequate micronutrients, there are several important reasons for focusing on micronutrients and health, particularly DNA damage: (1) More than 20 years of efforts to improve the American diet have not been notably successful, though this work must continue. A parallel approach focusing on micronutrient intake is overdue and might be more successful, since it should be easier to convince people to take a multivitamin/multimineral pill as insurance against ill health than to change their diet significantly. (2) A multivitamin/multimineral pill is inexpensive, is recognized as safe, and supplies the range of vitamins and minerals that a person requires, though not the essential fatty acids. Fortification of food is another approach that is useful, but its implementation has been very slow, as with folic acid fortification. Moreover, fortification of food does not allow for differences between individuals. For example, menstruating women need more iron than men or postmenopausal women, who may be getting too much. That is why two types of vitamin pills are marketed, one with iron and one without. With better knowledge it seems likely that a broader variety of multivitamin/multimineral pills will be developed, reflecting such life-stage differences.

The above issues and many others discussed in this book highlight the need to educate the public about the crucial importance of optimal nutrition and the potential health benefits of something as simple and affordable as a daily

multivitamin/multimineral supplement. The numerous advances in the science of nutrition and changing ideas about optimal intakes of micronutrients make *An Evidence-based Approach to Vitamins and Minerals: Health Benefits and Intake Recommendations* an excellent and timely resource. Dr. Higdon, who had a background in health care and nutrition science, and Dr. Drake, who has an expertise in toxicology and nutrition, have synthesized a large amount of recent scientific research on vitamins and nutritionally essential minerals into an organized volume that includes information on optimal micronutrient intakes to prevent and treat chronic diseases. The book also contains much needed and up-to-date information on safety and drug interactions of vitamins and minerals. The credibility of this

book is enhanced by the fact that it is endorsed by the Linus Pauling Institute at Oregon State University and that each chapter has been critically reviewed by a recognized expert in the field. Tuning up the metabolism to maximize human health will require scientists, clinicians, and educators to abandon outdated paradigms of micronutrients merely preventing deficiency disease and to explore more meaningful ways to prevent chronic disease and achieve optimal health through optimal nutrition.

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# Preface to the Second Edition

I am honored to revise and update Dr. Jane Higdon's book, *An Evidence-based Approach to Vitamins and Minerals: Health Benefits and Intake Recommendations*. Since the first edition was published in 2003, there has been a dramatic expansion of the literature on the role of micronutrients in human health and disease. In this second edition, all 27 chapters have been revised to incorporate information from the relevant, more recently published peer-reviewed studies, especially studies with human subjects. This edition includes the latest recommendations by the Food and Nutrition Board (FNB) of the Institute of Medicine: the FNB established new dietary reference intakes for potassium and sodium in 2004 and revised their recommendations for calcium and vitamin D in 2010. Additionally, some of the Linus Pauling Institute (LPI) recommendations have been modified to reflect current knowledge in micronutrient research. The LPI recommendations are daily intake levels aimed at the promotion of optimum health and prevention of chronic disease in healthy individuals. A large literature indicates that inadequate or marginal intake of vitamins and nutritionally essential minerals may increase one's risk for a number of diseases, including cardiovascular diseases, certain cancers and neurodegenerative diseases, and osteoporosis. Micronutrient inadequacy can also impair immunity and thus increase susceptibility to communicable diseases like influenza. This book reviews the present knowledge on the roles of

vitamins and minerals in disease prevention and disease treatment, in addition to providing basic information on biological function, deficiency, food sources, safety, and interactions with other micronutrients and drugs.

## Acknowledgments

I wish to thank the faculty, staff, and students of the Linus Pauling Institute for their editorial advice and support in the revision of this book, especially Balz Frei, PhD, director and endowed chair; Stephen Lawson, administrative officer; and Barbara McVicar, assistant to the director. I am very appreciative to all of the distinguished scientists listed in the Editorial Advisory Board, who reviewed the contents of each chapter and provided helpful comments. I am particularly grateful to Donald M. Mock, MD, PhD, and Eva Obarzanek, PhD, for their valuable expertise in revising the chapters on biotin and salt, respectively. Finally, I deeply appreciate the skillful work by Dr. Higdon in writing the first edition of this book, which has been a popular resource for both health professionals and the public.

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## Preface to the First Edition

During my clinical training, I learned to approach micronutrient nutrition from the perspective of preventing or treating deficiency diseases, such as scurvy or iron-deficiency anemia. In clinical practice, I became increasingly interested in the potential for micronutrients to prevent and treat chronic diseases at intakes higher than those required to prevent deficiency. However, the standard medical and nutrition texts of the day rarely provided the kind of information I was looking for. Today, scientific and medical research on the roles of micronutrients in health and disease is expanding rapidly, as are, unfortunately, exaggerated health claims from numerous supplement manufacturers. Keeping up with the explosion of contradictory information regarding the safety and efficacy of dietary supplements has become an overwhelming task for consumers as well as health care and nutrition professionals. My goal in writing this book was to provide clinicians and consumers with a practical evidence-based reference to the rapidly expanding field of micronutrient nutrition.

While my own interest in nutrition and health led me to pursue doctoral work in nutrition and biochemistry, such a step should not be necessary for health care and nutrition professionals who want more information on the health implications of dietary and supplemental micronutrients. With the support of the Linus Pauling Institute at Oregon State University (LPI), I have synthesized and organized hundreds of experimental, clinical, and epidemiologic studies, providing an overview of the current scientific knowledge of the roles of vitamins and nutritionally important minerals in human health and disease. To ensure the accuracy of the information presented, I asked at least one recognized scientific expert in the field to review each chapter. The names and affiliations of these scientists are listed in the Editorial Advisory Board.

Throughout this book, I have tried to emphasize human research published in peer-reviewed journals. Where relevant, I have included the results of experimental studies in cell culture or animal models. Although randomized clinical tri-

als provide the strongest evidence for the effect of micronutrient intake on disease outcomes in humans, it is not always ethical or practical to perform a double-blind, placebo-controlled trial. Observational studies can also provide useful information about micronutrient intake and disease outcomes. In reviewing the epidemiologic research, I have given more weight to the results of large prospective cohort studies, such as the Nurses Health Study, than retrospective case-control or cross-sectional studies. When available, I have included the results of systematic reviews and meta-analyses, which summarize information on the findings of many similar studies.

Nearly 35 years ago Linus Pauling, PhD, the only individual ever to win two unshared Nobel Prizes, concluded that micronutrients could play a significant role in enhancing human health and preventing chronic disease, not just deficiency disease. The basic premise that an optimum diet is the key to optimum health continues today as the foundation of the Linus Pauling Institute at Oregon State University. Scientists at the Linus Pauling Institute investigate the roles that micronutrients and other dietary constituents play in human aging and chronic diseases, particularly cancer, cardiovascular diseases, and neurodegenerative diseases. The goals of our research are to understand the molecular mechanisms behind the effects of nutrition on health and to determine how micronutrients and other dietary factors can be used in the prevention and treatment of diseases, thereby enhancing human health and well-being. The Linus Pauling Institute is also dedicated to training and supporting new researchers in the interdisciplinary science of nutrition and optimum health, as well as to educating the public about the science of optimum nutrition.

As you read this book, it will become apparent that the Linus Pauling Institute recommendations for certain micronutrients (e.g., vitamin C) differ considerably from those of Linus Pauling himself. Dr. Pauling, for whom the Linus Pauling Institute has great respect, based his own micro-

nutrient recommendations largely on theoretical arguments. For example, in developing his recommendations for vitamin C intake, he used cross-species comparisons, evolutionary arguments, and the amount of vitamin C likely consumed in a raw plant food diet. At the Linus Pauling Institute, we base our micronutrient recommendations on current scientific evidence, much of which was unavailable to Dr. Pauling. The Linus Pauling Institute's recommendation for a vitamin C intake of at least 200 mg/day for generally healthy adults takes into account the currently available epidemiologic, biochemical, and clinical evidence. Similarly, the Linus Pauling Institute's intake recommendation for each micronutrient in this book is based on the current scientific research available, while, in many cases, acknowledging that the intake levels most likely to promote optimum health remain to be determined.

## Acknowledgments

First and foremost, I wish to thank the faculty, staff, and students of the Linus Pauling Institute for providing me with the inspiration and the opportunity to write this book. Specifically, Balz Frei, PhD, the director, and Stephen Lawson, the chief administrative officer of the Linus Pauling Institute, provided valuable advice and editorial assistance throughout the project. Barbara

McVicar also provided much needed technical assistance and support. I am very grateful for the support of Bruce N. Ames, PhD, who was enthusiastic about this project from the beginning. His research and his eloquent foreword have been invaluable in laying the groundwork for this book.

I would like to thank each of the distinguished scientists listed in the Editorial Advisory Board for taking the time to carefully review each chapter of this book and provide insightful and constructive comments. I am also grateful to Aram Chobanian, MD, for reviewing the information presented on salt. The artist, Pat Grimaldi of the Communication Media Center at Oregon State University, was both patient and skillful in creating the book's illustrations.

This project would not have been possible without the generous financial support of the donors to the Linus Pauling Institute, who deserve special thanks. Finally, although I did not know him personally, I would like to thank Dr. Linus Pauling for courageously stimulating scientific, medical, and popular interest in the roles played by micronutrients in promoting optimum health and preventing and treating disease.

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