

**DRI**



**DIETARY REFERENCE INTAKES**

*FOR*

***Vitamin A,  
Vitamin K,  
Arsenic, Boron,  
Chromium,  
Copper,  
Iodine, Iron,  
Manganese,  
Molybdenum,  
Nickel, Silicon,  
Vanadium,  
and Zinc***

A Report of the  
Panel on Micronutrients,  
Subcommittees on Upper Reference Levels of Nutrients and of  
Interpretation and Uses of Dietary Reference Intakes, and the  
Standing Committee on the Scientific Evaluation of  
Dietary Reference Intakes

Food and Nutrition Board  
Institute of Medicine

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The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The image adopted as a logotype by the Institute of Medicine is based on a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin.

*“Knowing is not enough; we must apply.  
Willing is not enough; we must do.”*  
—Goethe



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# Preface

This report is one in a series that presents a comprehensive set of reference values for nutrient intakes for healthy U.S. and Canadian populations. It is a product of the Food and Nutrition Board of the Institute of Medicine (IOM) working in cooperation with Canadian scientists.

The report establishes a set of reference values for vitamin A, vitamin K, chromium, copper, iodine, iron, manganese, molybdenum, and zinc to replace previously published Recommended Dietary Allowances (RDAs) and Recommended Nutrient Intakes (RNIs) for the United States and Canada. The report also examines data about arsenic, boron, nickel, silicon, and vanadium. Although all reference values are based on data, available data often were scanty or drawn from studies that had limitations in addressing the various questions that confronted the Panel. Thus, although governed by reasoning, informed judgments often were required in setting reference values. The reasoning used is described for each nutrient in Chapters 4 through 13.

Close attention was given to the evidence relating intake of micronutrients to reduction of the risk of chronic disease, and the daily amounts needed to maintain normal status based on biochemical indicators and daily body losses. In addition, a major task of the Panel on Micronutrients, Subcommittee on Upper Reference Levels of Nutrients (UL Subcommittee), and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes (DRI Committee) was to analyze the evidence on beneficial and adverse effects

of arsenic, boron, nickel, silicon, and vanadium—in the context of setting Dietary Reference Intakes (DRIs).

Another major task of the report was to outline a research agenda to provide a basis for future public policy decisions related to recommended intakes of these micronutrients and ways to achieve those intakes. Many of the questions that were raised about requirements for and recommended intakes of micronutrients were not answered fully because of inadequacies in the published database. Apart from studies of overt deficiency diseases, there is a dearth of studies that address specific effects of inadequate micronutrient intakes on health status. For most of the micronutrients, there is no direct information that permits estimating the amounts required by children, adolescents, the elderly, and pregnant and lactating women. For four of the micronutrients, data were sparse for setting Tolerable Upper Intake Levels (ULs), precluding reliable estimates of how much can be ingested safely. For some of these micronutrients, there are questions about how much is contained in the foods North Americans eat.

Readers are urged to recognize that the establishment of DRIs is an iterative process that is expected to evolve as its conceptual framework is applied to new nutrients and food components. With more experience, the proposed models for establishing reference intakes of nutrients and food components that play a role in health will be refined. Also, as new information or new methods of analysis are adopted, these reference values undoubtedly will be reassessed.

Thus, because the project is ongoing, many comments were solicited and have been received on the reports that have been previously published. Refinements that have resulted from this iterative process have been included in the general information regarding approaches used (Chapters 1 through 3) and in the discussion of uses of DRIs (Chapter 14 in this report).

The Subcommittee on the Interpretation and Uses of Dietary Reference Intakes (Uses Subcommittee), formed subsequent to the release of the first two reports, has been primarily responsible for chapter 14, which addresses major issues conceptually included since the beginning of the DRI process that relate to the anticipated uses and applications of reference values as developed further by the Uses Subcommittee.

This report reflects the work of the Food and Nutrition Board's DRI Committee, its expert Panel on Micronutrients, and the UL and Uses Subcommittees. We gratefully acknowledge the support of the government of Canada and Canadian scientists in this initiative

that represents a pioneering first step in the standardization of nutrient reference intakes at least within a major part of one continent. A brief description of the overall project of the DRI Committee and of the panel's task is given in Appendix A. We hope that the critical, comprehensive analyses of available information and knowledge gaps contained in this initial series of reports will assist the private sector, foundations, universities, government laboratories, and other institutions with the development of a productive research agenda for the next decade.

The DRI Committee, the Panel on Micronutrients, the UL and Uses Subcommittees, and the Food and Nutrition Board wish to extend sincere thanks to the many experts who assisted with this report by giving presentations, providing written materials, participating in discussions, analyzing data, and other means. Many, but far from all, of these individuals are named in Appendix B. Special thanks go to George Beaton and the staff at the National Center for Health Statistics, the Food Surveys Research Group of the Agricultural Research Service, ENVIRON Corporation, Health Technomics, and the Department of Statistics at Iowa State University for extensive analyses of survey data.

The respective chairs and members of the Panel on Micronutrients and subcommittees have performed their work under great time pressure. Their dedication made the completion of this report possible. All gave of their time willingly and without financial reward; the public and the science and practice of nutrition are among the major beneficiaries.

The DRI Committee and the Food and Nutrition Board wish to acknowledge, in particular, the commitment shown by Robert Russell, Chair of the Panel on Micronutrients, who guided this difficult project through challenging and innovative paths. His ability to keep the effort and various biases moving in a positive direction is very much appreciated. Thanks are also due to the DRI Committee members, Lindsay Allen and William Rand, who served as in-depth internal reviewers for this report.

Special thanks also are expressed to the staff of the Food and Nutrition Board and foremost to Paula Trumbo, who was the study director for the panel and without whose assistance, both intellectual and managerial, this report would neither have been as polished nor as timely in its release. It is, of course the Food and Nutrition Board staff who get much of the work completed and so the panel, committees, and the Food and Nutrition Board wish to thank Allison Yates, Director of the Food and Nutrition Board, for her and her

staff's constant assistance. Thus, we also recognize and appreciate the contributions of Sandra Schlicker, Mary Poos, Elisabeth Reese, Alice Vorosmarti, Gail Spears, and Michele Ramsey and thank Pat Stephens for editing the manuscript, Jacqueline Dupont for technical review, and Claudia Carl for assistance with publication.

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*Chair*, Standing Committee on the Scientific  
Evaluation of Dietary Reference Intakes

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*Chair*, Food and Nutrition Board

# Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Sarah L. Booth, Tufts University  
James D. Cook, Kansas University Medical Center  
Mark L. Failla, University of North Carolina  
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Phylis B. Moser-Veillon, University of Maryland  
Robert S. Parker, Cornell University  
John B. Stanbury, Massachusetts General Hospital  
Clive E. West, Wageningen Agricultural University

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the

conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Kurt J. Isselbacher, Massachusetts General Hospital and Ronald W. Estabrook, University of Texas Southwestern Medical Center at Dallas. Appointed by the National Research Council and Institute of Medicine, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committees and the institution.

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Vanadium,  
and Zinc*

