

CRC

HANDBOOK SERIES
in
NUTRITION
and
FOOD

M. RECHCIGL, JR.

**SECTION D:
NUTRITIONAL
REQUIREMENTS
VOLUME I**

CRC

PRESS

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in

Nutrition and Food

Miloslav Rechcigl, Jr., Editor-in-Chief

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U.S. Department of State

Section D: Nutritional Requirements

Volume I

Comparative and Qualitative Requirements



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CRC HANDBOOK SERIES IN NUTRITION AND FOOD

Miloslav Rechcigl, Jr.
Editor-in-Chief

SECTION OUTLINE

SECTION A: Nutrition and Food Science

Minimum of 1 volume projected.

Nomenclature, Nutrition Literature, Nutrition Societies, Foundations, and Historical Milestones in Nutrition.

SECTION B: The Living Organisms, Their Chemical Constitution, Feeding and Digestive System, and Ecological Aspects

Minimum of 3 volumes projected.

Taxonomy, Distribution of Organisms, Ecology — Symbiosis, Feeding and Digestive System, Chemical Constitution of Organisms, and Biological Productivity.

SECTION C: The Nutrients and Their Metabolism

Minimum of 1 volume projected.

Nutrients and Growth Regulators, Antinutrients and Antimetabolites, Naturally Occurring Food Toxicants, Regulatory Aspects of Nutrition, and Availability of Nutrients.

SECTION D: Nutritional Requirements

Minimum of 4 volumes projected.

Comparative Requirements of Organisms, Qualitative Requirements of Specific Organisms, Quantitative Requirements (Nutritional Standards), and Nutritional Requirements for Specific Processes and Functions: Animals, Microorganisms, Plants.

SECTION E: Nutritional Disorders

Minimum of 2 volumes projected.

Nutritional Disorders in Living Organisms, Effect of Specific Nutrient Deficiencies and Toxicities, and Nutritional Disorders in Specific Tissues.

SECTION F: Food Composition

Minimum of 1 volume projected.

Nutrient Content and Energy Value of Food, Factors Affecting Nutrient Composition of Food, and Utilization and Biological Value of Food.

SECTION G: Diets, Culture Media, and Food Supplements

Minimum of 4 volumes projected.

Diets, Culture Media, and Food and Feed Supplements.

SECTION H: The State of World Food and Nutrition

Minimum of 1 volume projected.

World Population, Natural and Food Resources, Food Production, Food Losses, World Food Usage and Consumption, Geographic Distribution of Nutritional Diseases, Nutritional Requirements — Current and Projected, Agricultural Inputs — Current and Projected, Food Aid, Food Marketing and Distribution, Socioeconomic, Cultural, and Psychological Factors Affecting Nutrition.

SECTION I: Food Safety, Food Processing, Food Preservation

Minimum of 1 volume projected.

Food Contamination, Food Spoilage, Food Wastes, Food Laws, and Nutrition Labeling.

SECTION J: Nutrition and Food Methodology

Minimum of 1 volume projected.

Assessment of Nutritional Status, and Measuring Nutritive Value of Food.

PUBLISHER'S PREFACE

In 1913, when the First Edition of the *Handbook of Chemistry and Physics* appeared, scientific progress, particularly in chemistry and physics, had produced an extensive literature but its utility was seriously handicapped because it was fragmented and unorganized. The simple but invaluable contribution of the *Handbook of Chemistry and Physics* was to provide a systematic compilation of the most useful and reliable scientific data within the covers of a single volume. Referred to as the "bible," the Handbook soon became a universal and essential reference source for the scientific community. The 57th Edition, published in the bicentennial year of 1976, represents more than 63 years of continuous service to millions of professional scientists and students throughout the world.

In the years following World War II, scientific information expanded at an explosive rate due to the tremendous growth of research facilities and sophisticated analytical instrumentation. The single-volume Handbook concept, although providing a high level of convenience, was not adequate for the reference requirements of many of the newer scientific disciplines. Due to the sheer quantity of useful and reliable data being generated, it was no longer feasible or desirable to select only that information which could be contained in a single volume and arbitrarily to reject the remainder. **Comprehensiveness** had become as essential as **convenience**.

By the late 1960's, it was apparent that the solution to the problem was the development of the multi-volume Handbook. This answer arose out of necessity during the editorial processing of the *Handbook of Environmental Control*. A hybrid discipline or, to be more precise, an interdisciplinary field such as Environmental Science could be logically structured into major subject areas. This permitted individual volumes to be developed for each major subject. The individual volumes, published either simultaneously or by some predetermined sequence, collectively became a multi-volume Handbook series.

The logic of this new approach was irrefutable and the concept was promptly accepted by both the scientist and science librarian. It became the format of a growing number of CRC Handbook Series in fields such as Materials Science, Laboratory Animal Science, and Marine Science.

Within a few years, however, it was clear that even the multi-volume Handbook concept was not sufficient. It was necessary to create an information structure more compatible with the dynamic character of scientific information, and flexible enough to accommodate continuous but unpredictable growth, regardless of quantity or direction. This became the objective of a "third generation" Handbook concept.

This latest concept utilizes each major subject within an information field as a "Section" rather than the equivalent of a single volume. Each Section, therefore, may include as many volumes as the quantity and quality of available information will justify. The structure achieves permanent flexibility because it can, in effect, expand "vertically" and "horizontally." Any section can continue to grow (vertically) in number of volumes, and new sections can be added (horizontally) as and when required by the information field itself. A key innovation which makes this massive and complex information base almost as convenient to use as a single-volume Handbook is the utilization of computer technology to produce up-dated, cumulative index volumes.

The *Handbook Series in Nutrition and Food* is a notable example of the “sectionalized, multi-volume Handbook series.” Currently underway are additional information programs based on the same organizational design. These include information fields such as Energy and Agricultural Science which are of critical importance not only to scientific progress but to the advancement of the total quality of life.

We are confident that the “third generation” CRC Handbook comprises a worthy contribution to both information science and the scientific community. We are equally certain that it does not represent the ultimate reference source. We predict that the most dramatic progress in the management of scientific information remains to be achieved.

B. J. Starkoff
President
CRC Press, Inc.

PREFACE

CRC HANDBOOK SERIES IN NUTRITION AND FOOD

Nutrition means different things to different people, and no other field of endeavor crosses the boundaries of so many different disciplines and abounds with such diverse dimensions. The growth of the field of nutrition, particularly in the last two decades, has been phenomenal, the nutritional data being scattered literally in thousands and thousands of not always accessible periodicals and monographs, many of which, furthermore, are not normally identified with nutrition.

To remedy this situation, we have undertaken an ambitious and monumental task of assembling in one publication all the critical data relevant in the field of nutrition.

The *CRC Handbook Series in Nutrition and Food* is intended to serve as a ready reference source of current information on experimental and applied human, animal, microbial, and plant nutrition presented in concise tabular, graphical, or narrative form and indexed for ease of use. It is hoped that this projected open-ended multivolume set will become for the nutritionist what the *CRC Handbook of Chemistry and Physics* has become for the chemist and physicist.

Apart from supplying specific data, the comprehensive, interdisciplinary, and comparative nature of the *CRC Handbook Series in Nutrition and Food* will provide the user with an easy overview of the state of the art, pinpointing the gaps in nutritional knowledge and providing a basis for further research. In addition, the *Handbook* will enable the researcher to analyze the data in various living systems for commonality or basic differences. On the other hand, an applied scientist or technician will be afforded the opportunity of evaluating a given problem and its solutions from the broadest possible point of view, including the aspects of agronomy, crop science, animal husbandry, aquaculture and fisheries, veterinary medicine, clinical medicine, pathology, parasitology, toxicology, pharmacology, therapeutics, dietetics, food science and technology, physiology, zoology, botany, biochemistry, developmental and cell biology, microbiology, sanitation, pest control, economics, marketing, sociology, anthropology, natural resources, ecology, environmental science, population, law, politics, nutritional and food methodology, and others.

To make more facile use of the *Handbook*, the publication has been divided into sections of one or more volumes each. In this manner the particular sections of the *Handbook* can be continuously updated by publishing additional volumes of new data as they become available.

The Editor wishes to thank the numerous contributors, many of whom have undertaken their assignment in pioneering spirit, and the Advisory Board members for their continuous counsel and cooperation. Last but not least, he wishes to express his sincere appreciation to the members of the CRC editorial and production staffs, particularly President Bernard J. Starkoff, Mr. Gerald A. Becker, Mrs. Kathryn H. Harter, Mrs. Karen G. Ketchaver, and Mr. Paul R. Gottehrer, for their encouragement and support.

We invite comments and criticism regarding format and selection of subject matter, as well as specific suggestions for new data (and additional contributors) which might be included in subsequent editions. We should also appreciate it if the readers would bring to the attention of the Editor any errors or omissions that might appear in the publication.

Miloslav Rechcigl, Jr.
Editor-in-Chief
October 1976

PREFACE

SECTION D: NUTRITIONAL REQUIREMENTS

The section of the *CRC Handbook Series in Nutrition and Food* on nutritional requirements is projected into several volumes.

The first volume contains information relating to the qualitative requirements and utilization of nutrients in major classes of organisms, covering both plant and animal kingdoms and including microorganisms. Pertinent material is also presented on the nutritional requirements of cells and tissues.

Whenever possible, we have tried to indicate the essentiality or degree of utilization of nutrients by appropriate symbols such as R, required; \bar{R} , not required; U, utilized; u, poorly utilized; \bar{U} , not utilized; S, stimulatory, supportive (growth); s, moderately supportive; \bar{S} , not supportive; E, essential; \bar{E} , nonessential, etc.

During the preparation of this section, especially this volume, it soon became apparent that the information for many classes of organisms was either negligible or nonexistent. This was particularly true in the field of invertebrates and plants. Our knowledge of cellular requirements is also in rudimentary stages. Nevertheless, for the sake of completeness we have made an earnest effort to cover the nutritional needs of as many groups of organisms as possible, with the full realization that some of the conclusions will have to be modified as new experimental data become available. This is to be expected, especially for those systems in which the conclusions are based on indirect evidence, such as composition of typical food sources on which such organisms subsist.

The subsequent volumes will contain (1) additional nutritional data of the qualitative nature, (2) information relating to quantitative requirements (nutritional standards) of selected species of organisms for which the data are available, and (3) information on nutritional requirements for specific processes and functions.

Miloslav Rechcigl, Jr.
Editor
January 1977

MILOSLAV REHCIGL, JR., EDITOR

Miloslav Rechcigl, Jr. is Nutrition Advisor and Director of the Interregional Research Staff in the Agency for International Development, U.S. Department of State.

He has a B.S. in Biochemistry (1954), a Master of Nutritional Science degree (1955), and a Ph.D. in nutrition, biochemistry, and physiology (1958), all from Cornell University. He was formerly a Research Biochemist in the National Cancer Institute, National Institutes of Health and subsequently served as Special Assistant for Nutrition and Health in the Health Services and Mental Health Administration, U.S. Department of Health, Education, and Welfare.

Dr. Rechcigl is a member of some 30 scientific and professional societies, including being a Fellow of the American Association for the Advancement of Science, Fellow of the Washington Academy of Sciences, Fellow of the American Institute of Chemists, and Fellow of the International College of Applied Nutrition. He holds membership in the Cosmos Club, the Honorary Society of Phi Kappa Pi, and the Society of Sigma Xi, and is recipient of numerous honors, including an honorary membership certificate from the International Social Science Honor Society Delta Tau Kappa. In 1969, he was a delegate to the White House Conference on Food, Nutrition, and Health and in the last two years served as President of the District of Columbia Institute of Chemists and a Councilor of the American Institute of Chemists.

His bibliography extends over 100 publications, including contributions to books, articles in periodicals, and monographs in the fields of nutrition, biochemistry, physiology, pathology, enzymology, and molecular biology. Most recently he authored and edited *World Food Problem: A Selective Bibliography of Reviews* (CRC Press, 1975), *Man, Food, and Nutrition: Strategies and Technological Measures for Alleviating the World Food Problem* (CRC Press, 1973), *Food, Nutrition and Health: A Multidisciplinary Treatise Addressed to the Major Nutrition Problems from a World Wide Perspective* (Karger, 1973), following his earlier pioneering treatise on *Enzyme Synthesis and Degradation in Mammalian Systems* (Karger, 1971), and that on *Microbodies and Related Particles. Morphology, Biochemistry and Physiology* (Academic Press, 1969). Dr. Rechcigl also has initiated and edits a new series on Comparative Animal Nutrition and is Associated Editor of *Nutrition Reports International*.

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