



# CRC Handbook of Microbiology

2nd Edition

## Volume V Microbial Products

Editors

**Allen I. Laskin**

Exxon Research and Engineering Company

**Hubert A. Lechevalier**

Waksman Institute of Microbiology  
Rutgers University

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**CRC HANDBOOK OF MICROBIOLOGY**

**EDITORS:**

**A. I. Laskin, Ph.D.**

**H. A. Lechevalier, Ph.D.**

Outline for the Second Edition

**Volume I  
BACTERIA**

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FUNGI, ALGAE, PROTOZOA, AND VIRUSES**

**Volume III  
MICROBIAL COMPOSITION:  
Amino Acids, Proteins, and  
Nucleic Acids**

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**Volume VII  
MICROBIAL TRANSFORMATION**

**Volume VIII  
GENETICS AND IMMUNOLOGY**

**Volume IX  
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**N. Winskill**  
Fermentation Production Manager  
International Manufacturing Division  
Pfizer New York  
New York, New York

**J. L. C. Wright**  
Atlantic Research Laboratory  
National Research Council  
Halifax, Nova Scotia  
Canada

## *Substances Related to Carbohydrates*

**Gerhard J. Haas**

Research Scientist  
General Foods Corp.  
Technical Center  
White Plains, New York

**Thomas H. Haines**

Professor of Chemistry  
Professor of Biochemistry  
City College of CUNY  
New York, New York

**Theodore H. Haskell**

Retired  
Section Director-Anti-infectives  
Warner Lambert/Parke Davis  
Ann Arbor, Michigan

**Derek J. Hook**

Senior Fermentation Biochemist  
Bristol Myers Industrial Division  
Fermentation Development  
Syracuse, New York

**Ulfert Hornemann**

Professor of Pharmacological  
Biochemistry  
Center for Health Sciences  
School of Pharmacology  
University of Wisconsin  
Madison, Wisconsin

**Anita Johnson**

Research Aid  
Department of Botany  
Duke University  
Durham, North Carolina

**Alan Jones**

Division of Biochemistry  
Department of Chemistry  
University of Calgary  
Calgary, Alberta  
Canada

**Ewart Jones**

Emeritus Professor  
Dyson Perrins Laboratory  
Oxford University  
Oxford  
England

**E. Katz**

Department of Microbiology  
Georgetown University School of  
Medicine and Dentistry  
Washington, D.C.

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Professor of Organic Chemistry  
Organisch-chemisches Laboratorium  
Eidg. Technische Hochschule  
Zurich  
Switzerland

**D. J. Kushner**

Professor of Biology  
Department of Biology  
University of Ottawa  
Ottawa, Ontario  
Canada

**Chi-Hang Lee**

Corporate Scientist  
Del Monte Corp.  
Research Center  
Walnut Creek, California

**J. M. Lynch**

Head, Plant Pathology and Microbiology  
Department  
Glasshouse Crops Research Institute  
Littlehampton  
West Sussex  
England

**Anthony B. Mauger**

Washington Hospital Center  
George Hyman Research Center  
Washington, D.C.

**Withold Mechlinski**

Senior Scientist  
Ortho Diagnostics Systems, Inc.  
Raritan, New Jersey

**J. A. Narciso**

Research Associate  
Biological Sciences Group, Botany  
Section  
University of Connecticut  
Storrs, Connecticut

**K. Paramasigamani**

Department of Biology  
Dalhousie University  
Halifax, Nova Scotia  
Canada

**G. Pattenden**

Professor of Chemistry  
Department of Chemistry  
University of Nottingham  
Nottingham  
England

**Henry Paulus**

Director, Department of Metabolic  
Regulation  
Boston Biomedical Research Institute  
Boston, Massachusetts

**P. M. Rhodes**

Celltech LTD.  
Slough, Berks  
England

**J. Shoji**

Shionogi Research Laboratory  
Shionogi and Company  
Osaka  
Japan

**George P. Slater**

Senior Research Officer  
Prairie Regional Laboratory  
National Research Council of Canada  
Saskatoon, Saskatchewan  
Canada

**Albert Stoessl**

Research Scientist  
Canada Agriculture  
Research Centre  
London, Ontario

**George M. Strunz**

Research Scientist  
Canadian Forestry Service  
New Brunswick  
Canada

**Paul E. Swanson**

Biotechnical Resources  
Manitowoc, Wisconsin

**Guy Talbot**

Department de Biochimie  
Faculte des Sciences et de Genie  
Universite Laval  
Quebec  
Canada

**V. Thaller**

University Lecturer  
Dyson Perrins Laboratory  
Oxford University  
Oxford  
England

**R. Thomas**

Professor  
Biotechnology Unit  
The University of Surrey  
Guildford, Surrey  
England

**Chase Van Baalen**

Professor  
Marine Studies and Botany  
Port Aransas Marine Laboratory  
University of Texas Marine Science  
Institute  
Port Aransas, Texas

**L. C. Vining**

Professor of Biology  
Department of Biology  
Dalhousie University  
Halifax, Nova Scotia  
Canada

**Chi-Kit Wat**

Research Associate  
Department of Botany  
University of British Columbia  
Vancouver, British Columbia  
Canada

**J. S. Webb**

Deceased  
Lederle Laboratories Division  
American Cyanide Company  
Pearl River, New York

**J. W. Westley**

Chemical Research Department  
Hoffmann-LaRoche, Inc.  
Nutley, New Jersey



**Chase Van Baalen, Ph.D.**

Marine Science Institute

University of Texas

Port Aransas, Texas

**Claude Vézina, Ph.D.**

Institut Armand-Frappier

Ville de Laval, Quebec, Canada

**L. C. Vining, Ph.D.**

Department of Biology

Dalhousie University

Halifax, N.S., Canada

**E. D. Weinberg, Ph.D.**

Department of Biology

Program in Medical Sciences

Indiana University

Bloomington, Indiana

## CONTRIBUTORS

**D. C. Aldridge**

Pharmaceutical Division  
Imperial Chemical Industries  
Macclesfield, Cheshire  
England

**Frank W. Bachelor**

Associate Professor of Chemistry  
Department of Chemistry  
The University of Calgary  
Calgary  
Canada

**Andrew D. Batcho**

Research Fellow  
Chemical Research Division  
Hoffmann La Roche, Inc.  
Nutley, New Jersey

**J. Berger**

308 Ayerigg Avenue  
Passaic, New Jersey

**D. R. Brannon**

Head, Toxicology Studies  
Lilly Research Laboratories  
Division of Eli Lilly and Co.  
Indianapolis, Indiana

**R. P. Collins**

Professor of Biology  
Biological Sciences Group, Botany  
Section  
University of Connecticut  
Storrs, Connecticut

**Louise W. Crandall**

Assistant Senior Biochemist  
Lilly Research Laboratories  
Division of Eli Lilly and Co.  
Indianapolis, Indiana

**Chicita F. Culberson**

Adjunct Professor of Botany  
Department of Botany  
Duke University  
Durham, North Carolina

**William Louis Culberson**

Professor of Botany  
Department of Botany  
Duke University  
Durham, North Carolina

**Phyllis Dale**

Botany Department  
University of Alberta  
Edmonton, Alberta  
Canada

**T. K. Devon**

Head, Research Information Services  
Pfizer Central Research (UK)  
Sandwich, Kent  
England

**H. Diekmann**

Professor  
Institut für Mikrobiologie  
Universität Hannover  
Hannover  
FR Germany

**Nancy N. Gerber**

Waksman Institute of Microbiology  
Rutgers State University  
Piscataway, New Jersey

**T. W. Goodwin**

Professor  
Head, Department of Biochemistry  
University of Liverpool  
Liverpool  
England

**Dieter Gross**

Senior Scientist  
Institute of Plant Biochemistry  
Academy of Sciences of the GDR  
German Democratic Republic

**J. F. Grove**

School of Molecular Sciences  
University of Sussex  
Falmer, Brighton, Sussex  
England

## PREFACE

Volume V of the 2nd Edition of the *CRC Handbook of Microbiology* is devoted to a survey of microbial products. In a subsequent volume of the series, Volume IX, will be found information on toxins, enzymes and antibiotics. In the case of antibiotics, many compounds may be found, with a coverage of a different slant, in both volumes. In Volume V, compounds are classified by chemical families; in Volume IX, the emphasis will be more biological.

The Editors wish to thank all the members of the Advisory Board for their assistance, but very special mention should be made of the most devoted help received from Professor Leo Vining, who reviewed all the entries in an effort to reduce duplication of treatment to a minimum.

Of course this volume would not have been possible without the gracious cooperation of all the authors who unselfishly donated their time and expertise. We can only hope that their reward will be in the assistance given to all those who will find the consultation of this book a valuable aid to their work.

## THE EDITORS

**Allen I. Laskin**, Head of Biosciences Research at Exxon Research and Engineering Company, Annandale, N.J., received his B.S. degree in Biology from the City College of New York in 1950. His M.A. and Ph.D. degrees in Microbiology were obtained from the University of Texas in 1952 and 1955, respectively.

From 1955 to 1969 Dr. Laskin was at the Squibb Institute for Medical Research, first as Senior Research Microbiologist, then as Head of Microbial Biochemistry, and subsequently as Assistant Director of Microbiology. His research on microbial transformations of steroids led to several publications and more than 20 U.S. patents. Dr. Laskin then switched to molecular biology and studies on cell-free protein and cell-wall synthesis, which led to work on the mode of action of tetracycline and several other antibiotics.

In 1969 Dr. Laskin joined Exxon Research and Engineering Company to head the laboratory program concerned with single-cell protein. In 1971 he moved to his present position, heading the research on petroleum microbiology and enzymology.

Dr. Laskin is past president of the Society of Industrial Microbiology and the Theobald Smith Society (New Jersey Branch, American Society for Microbiology) and was National Councilor for many years. He was Vice-Chairman of the local committee for the 1965 ASM National Meeting in Atlantic City and served as Chairman for the 1976 meeting. He was Chairman of the Environmental and General Applied Microbiology Division of ASM, Chairman of the Fermentation Division, and is presently a Divisional Group Councilor, coordinating the activities of four divisions of the Society. He was also on the Membership Committee of ASM and served as Chairman of its Sustaining Membership Sub-Committee. In addition, Dr. Laskin was Chairman of the Microbiology Section of the New York Academy of Sciences. He is a member of the Panel on Microbial Degradation of Oil of the American Petroleum Institute and was Chairman of a subgroup for a National Academy of Sciences/National Research Council Panel on Underutilized Microbial Processes of Potential Value.

In 1974 Dr. Laskin was awarded the Selman A. Waksman Honorary Lectureship Award. He is a fellow of the American Academy of Microbiology and a Fellow of the New York Academy of Sciences. In 1971 to 1972 he was a Foundation for Microbiology Lecturer, and in 1977 he was the I. M. Lewis (Texas Branch, ASM) Lecturer.

Dr. Laskin is not only Co-Editor of the *CRC Handbook of Microbiology* and of *CRC Critical Reviews in Microbiology*, but also of a series entitled *Methods in Molecular Biology* as well as of the books *Extracellular Microbial Polysaccharides*, *The Problems of Drug-Resistant Bacteria*, and *The Genetics of Industrial Microorganisms*. In addition, he serves as Editor for a series of books on microbiology. Dr. Laskin has also authored and co-authored reviews on the mode of action of tetracycline and on single-cell protein, and has organized and chaired numerous symposia, seminars, and conferences.

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## THE EDITORS

**Hubert A. Lechevalier**, Professor of Microbiology and Associate Director at the Waksman Institute of Microbiology of Rutgers University, New Brunswick, N.J., received a Licence ès Sciences Naturelles (*summa cum laude*) in 1947 and his M.S. degree (*cum laude*) in 1948 from Laval University, Quebec City, Canada. He obtained his Ph.D. from Rutgers University in 1951.

Dr. Lechevalier remained at Rutgers University as Assistant Professor of Microbiology from 1951 to 1956, and subsequently as Associate Professor, before advancing to Professor in 1966. Within this period he also was an exchange scientist at the Academy of Sciences of the U.S.S.R. in Moscow, Visiting Investigator at the Czechoslovak Academy of Sciences in Prague, and Visiting Investigator at the Pasteur Institute, Section of Mycology, in Paris. His research, dealing with actinomycetes and their products, has led to U.S. patents for neomycin and candicidin as well as to 16 foreign patents.

A recipient of Fellowships from the National Research Council of Canada, from Rutgers University, and from the U.S. Public Health Service, Dr. Lechevalier was also awarded membership in Sigma Xi and is an Associate Member of the Société Française de Microbiologie. In 1976 he received the Lindbach Award for Distinguished Research and in 1982, jointly with his wife Mary, the Charles Thom Award of the Society for Industrial Microbiology for outstanding contributions in the field of industrial microbiology.

In addition to his membership in the American Society for Microbiology (ASM), in the Canadian Society for Microbiologists, the Society for Industrial Microbiology, and in the Mycological Society of America, Dr. Lechevalier has served as a participant on the Editorial Boards of *Applied Microbiology* and of *Annales de Microbiologie*, on the subcommittee on the Taxonomy of the Actinomycetes of the International Committee on Bacteriological Nomenclature, on the Subcommittee on Tastes and Odors of the American Water Works Association, and on the ASM Archives Committee. He also served as Chairman of the ASM Subcommittee on Actinomycetes, as a Trustee of the American Type Culture Collection, and as consultant to various industrial and legal firms.

Dr. Lechevalier is not only Co-Editor of the *CRC Handbook of Microbiology* and a former Co-Editor of *CRC Critical Reviews in Microbiology*, but has also collaborated on a number of books: *A Guide to the Actinomycetes and Their Antibiotics*; *Neomycin — Nature, Formation, Isolation, and Practical Application*; *Neomycin — Its Nature and Practical Application*; *Antibiotics of Actinomycetes*; *Three Centuries of Microbiology*; *The Microbes*. He has also authored or co-authored numerous papers.

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**S. H. Hutner, Ph.D.**

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New Brunswick, New Jersey

**Yoshiro Okami, Ph.D.**

Institute of Microbial Chemistry  
Microbial Chemistry Research Foundation  
Shinagawa-Ku, Tokyo, Japan

**William M. O'Leary, Ph.D.**

Department of Microbiology  
Cornell University Medical College  
New York, New York

**David Perlman, Ph.D.**

Deceased  
School of Pharmacy  
University of Wisconsin  
Madison, Wisconsin

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Biochemical Research  
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Raritan, New Jersey

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Department of Food Science and  
Technology  
College of Agricultural and  
Environmental Sciences  
University of California  
Davis, California

**Thomas B. Platt, Ph.D.**

Bioanalytical Section  
The Squibb Institute of Medical Research  
New Brunswick, New Jersey

**Otto J. Plescia, Ph.D.**

Waksman Institute of Microbiology  
Rutgers University  
New Brunswick, New Jersey



SIMPLE ALIPHATIC SUBSTANCES, HYDROCARBONS, ESTERS,  
ALDEHYDES, KETONES, AND ALCOHOLS

**R. P. Collins and J. A. Narciso**

The following list is an extension of one originally compiled by Gerber. The list is still not exhaustive in that substances reported from various alcoholic beverages are not included. A list of compounds identified in whiskey, wine, and beer has been published (see Reference 3). Undoubtedly other pertinent papers have escaped the reviewers' attention. In some instances generic names have been corrected to conform with current usage. The older cited name is in brackets.