



MANUAL OF CLINICAL MICROBIOLOGY

Second Edition

EDITED BY

EDWIN H. LENNETTE

Chief, Viral and Rickettsial Disease Laboratory, California Department of Health, Berkeley, Calif.

EARLE H. SPAULDING

Department of Microbiology and Immunology, School of Medicine, Temple University Health Science Center, Philadelphia, Pa.

JOSEPH P. TRUANT

*Director of Microbiology-Immunology,
Advance Medical and Research Center, Pontiac, Mich.*

**AMERICAN SOCIETY
FOR MICROBIOLOGY**

Washington, D.C. 1974



MANUAL OF CLINICAL MICROBIOLOGY Second Edition

Copyright © 1970, 1974 American Society for Microbiology
Second Printing, 1975

Library of Congress Catalog Card Number 74-81968

ISBN 0-914826-00-X Cloth Binding
ISBN 0-914826-01-8 Plastic Binding

All rights reserved.
Printed in the United States of America.

AMERICAN SOCIETY FOR MICROBIOLOGY
1913 I St., N.W.
Washington, D.C. 20006

EDITED BY

EDWIN H. LENNETTE

Chief, Viral and Bacterial Disease Laboratory, California Department of Health, Berkeley, California

EARLE H. SPAULDING

Department of Microbiology and Immunology, School of Medicine, Temple University Health Science Center, Philadelphia, Pa.

JOSEPH P. TRUANT

Director of Microbiology-Immunology, Advance Medical and Research Center, Pontiac, Michigan



AMERICAN SOCIETY
FOR MICROBIOLOGY

Washington, D.C. 20006

EDITORIAL BOARD

- Albert Balows** **Sections I and II**
Chief, Bacteriology Division, Center for Disease Control, Atlanta, Georgia
- B. H. Cooper** **Section VII**
Assistant Professor of Microbiology, Temple University Medical School, Philadelphia, Pennsylvania
- Morris Dumoff** **Sections II and XI**
Microbiologist, McLaren General Hospital, St. Joseph Hospital, Flint Medical Laboratory, Flint, Michigan
- William H. Ewing** **Section II**
Consulting and Research Microbiologist, Center for Disease Control, Atlanta, Georgia
- Silas G. Farmer** **Sections II and VI**
Associate Professor of Pathology, Medical College of Wisconsin; Clinical Professor of Microbiology, Marquette University; Microbiologist, The Milwaukee County Medical Complex, Milwaukee, Wisconsin
- Joseph L. Melnick** **Section IX**
Professor of Virology and Epidemiology, and Chairman of Department of Virology and Epidemiology, Baylor University College of Medicine, Houston, Texas
- Nathalie J. Schmidt** **Section IX**
Research Specialist, Viral and Rickettsial Disease Laboratory, California Department of Health, Berkeley, California
- John C. Sherris** **Section V**
Professor and Chairman, Department of Microbiology, University of Washington, Seattle, Washington
- Louis DS. Smith** **Section IV**
Professor of Microbiology, Anaerobe Laboratory, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
- J. Clyde Swartzwelder** **Section VIII**
Professor of Medical Parasitology, and Head, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana

CONTRIBUTORS

Stanley H. Abadie

Professor of Medical Parasitology and Microbiology, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana

Libero Ajello

Chief, Mycology Division, Center for Disease Control, Atlanta, Georgia

Aaron D. Alexander

Director of Veterinary Medicine, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, DC

Howard R. Attebery

Research Microbiologist, Research Service, Wadsworth Hospital Center, Veterans Administration; and Research Dentist, Department of Pediatric Dentistry, University of California School of Dentistry (Los Angeles), Los Angeles, California

Robert Austrian

John Herr Musser Professor of Research Medicine, Department of Research Medicine, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania

Peter K. C. Austwick

Nuffield Research Fellow, Nuffield Institute of Comparative Medicine, The Zoological Society of London, Regent's Park, London, England

Albert Balows

Chief, Bacteriology Division, Center for Disease Control, Atlanta, Georgia

Arthur L. Barry

Lecturer in Infectious and Immunologic Diseases, University of California School of Medicine (Davis); and Director, Microbiology Laboratories, Sacramento Medical Center, University of California (Davis), Sacramento, California

Raymond C. Bartlett

Director, Division of Microbiology, and Assistant Director, Department of Pathology, Hartford Hospital, Hartford, Connecticut

Matilda Benyesh-Melnick

Professor of Virology and Epidemiology, Department of Virology and Epidemiology, Baylor College of Medicine, Houston, Texas

Susan T. Bickham

Microbiologist, Special Bacteriology Unit, Clinical Bacteriology Section, Center for Disease Control, Atlanta, Georgia

Patricia G. Bingham

Public Health Laboratory Technologist, Viral Vaccine Investigations Section, Center for Disease Control, Atlanta, Georgia

Francis L. Black

Associate Professor, Epidemiology and Microbiology, Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, Connecticut

Philip S. Brachman

Director, Bureau of Epidemiology, Center for Disease Control, Atlanta, Georgia

Marion M. Brooke

Supervisory Microbiologist, Laboratory Training and Consultation Branch, Bureau of Laboratories, Center for Disease Control, Atlanta, Georgia

Thomas R. Cate

Department of Medicine, Duke University Medical Center, Durham, North Carolina

B. Wesley Catlin

Professor of Microbiology, Department of Microbiology, The Medical College of Wisconsin, Milwaukee, Wisconsin

Dan C. Cavanaugh

Chief, Department of Hazardous Microorganisms, Division of Communicable Diseases and Immunology, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, DC

William B. Cherry

Chief, Analytical Bacteriology Branch, Center for Disease Control, Atlanta, Georgia

Marion T. Coleman

Acting Chief, Respiratory Virology Section, Center for Disease Control, Atlanta, Georgia

B. H. Cooper

Assistant Professor of Microbiology, Temple University Medical School, Philadelphia, Pennsylvania

Clyde G. Culbertson

Lilly Laboratory for Clinical Research, Marion County General Hospital, Indianapolis, Indiana

R. H. Deibel

Professor of Bacteriology, University of Wisconsin, Madison, Wisconsin

Friedrich W. Deinhardt

Professor and Chairman, Department of Microbiology, Rush-Presbyterian-St. Luke's Medical Center, Chicago, Illinois

Walter R. Dowdle

Chief, Virology Branch, Center for Disease Control, Atlanta, Georgia

V. R. Dowell, Jr.

Chief, Enterobacteriology Section, Bacteriology Division, Center for Disease Control, Atlanta, Georgia

Morris Dumoff

Microbiologist, McLaren General Hospital, St. Joseph Hospital, Flint Medical Laboratory, Flint, Michigan

Charles L. Duncan

Associate Professor, Food Research Institute and Department of Bacteriology, University of Wisconsin, Madison, Wisconsin

Henry T. Eaglesbach

US Army Research Institute for Infectious Disease, Frederick, Maryland

George H. G. Eisenberg, Jr.

Plague Section, Department of Hazardous Microorganisms, Division of Communicable Diseases and Immunology, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, DC

Ana Espinel-Ingroff

Research Technologist, Division of Allergy and Infectious Diseases, Medical College of Virginia, Virginia Commonwealth University, Richmond, Virginia

William H. Ewing

Consulting and Research Microbiologist, Center for Disease Control, Atlanta, Georgia

Richard R. Facklam

Chief, Staphylococcus and Streptococcus Unit, Clinical Bacteriology Section, Bacteriology Branch, Center for Disease Control, Atlanta, Georgia

Silas G. Farmer

Associate Professor of Pathology, Medical College of Wisconsin, Clinical Professor of

Microbiology, Marquette University; and Microbiologist, The Milwaukee County Medical Complex, Milwaukee, Wisconsin

James C. Feeley

Chief, Special Pathogens Unit, Epidemiologic Services Laboratory Section, Bacterial Diseases Branch, Center for Disease Control, Atlanta, Georgia

John C. Feeley

Chief, Bacterial Immunology Section, Bacteriology Branch, Center for Disease Control, Atlanta, Georgia

Mark R. Feldman

Research Associate, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana

Sydney M. Finegold

Chief, Infectious Disease Section, Wadsworth Hospital Center, Veterans Administration, Professor of Medicine, University of California School of Medicine, Los Angeles, California

Richard K. Forster

Assistant Professor, Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami School of Medicine, Miami, Florida

E. M. Foster

Professor of Bacteriology and Director, Food Research Institute, University of Wisconsin, Madison, Wisconsin

Vincent A. Fulginiti

Professor and Head, Department of Pediatrics, University of Arizona, Arizona Medical Center, Tucson, Arizona

Paul Gerber

Chief, Viral Genetics Branch, Bureau of Biologics, Food and Drug Administration, Rockville, Maryland

Gerald L. Gilardi

Microbiologist, Microbiology Division, Department of Laboratories, Hospital for Joint Diseases and Medical Center, New York, New York

J. M. Goepfert

Associate Professor, Food Research Institute, University of Wisconsin, Madison, Wisconsin

Norman L. Goodman

Associate Professor and Director of Mycology Laboratories, Department of Community Medicine, A. B. Chandler Medical Center, University of Kentucky, Lexington, Kentucky

Morris A. Gordon

Director, Laboratories for Mycology, Division of Laboratories and Research, New York State Department of Health, Albany, New York

Donald L. Greer

Assistant Director, ICMR, Tulane University; and Associate Professor, Medical Mycology, Universidad del Valle, Cali, Colombia, South America

Dieter H. M. Gröschel

Associate Professor of Pathology and Microbiology, University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute; and Associate Professor of Medicine and Pathology, University of Texas Medical School, Houston, Texas

Lavelle Hanna

Specialist, Department of Microbiology, University of California, San Francisco, California

William Hausler, Jr.

State Hygienic Laboratory, University of Iowa, Iowa City, Iowa

George J. Hermann

Chief, Enteric Unit, Bacteriology Division, Center for Disease Control, Atlanta, Georgia

- Ernest C. Herrmann, Jr.**
Associate Professor, Peoria School of Medicine, Peoria, Illinois
- F. Blaine Hollinger**
Associate Professor of Virology and Epidemiology, Department of Virology and Epidemiology, Baylor College of Medicine, Houston, Texas
- Robert H. Huffaker**
Chief, Office of Biosafety, Center for Disease Control, Atlanta, Georgia
- Rudolph Hugh**
Professor of Microbiology, George Washington University School of Medicine, Washington, DC
- Henry D. Isenberg**
Long Island Jewish-Hillside Medical Center, New Hyde Park, New York
- Daniel Ivler**
Professor of Pediatrics and Microbiology, University of Southern California School of Medicine; Director, Microbiology Research, Hastings Foundation Infectious Disease Laboratory, Los Angeles County—University of Southern California Medical Center; and Associate Dean, University of Southern California, School of Medicine, Los Angeles, California
- Ernest Jawetz**
Professor and Chairman, Department of Microbiology, University of California, San Francisco, California
- Harald Norlin Johnson**
Staff Member, Viral and Rickettsial Disease Laboratory, California Department of Health, and Lecturer, School of Public Health, University of California, Berkeley, California
- Wallis L. Jones**
Assistant Chief, Bacterial Immunology Section, Center for Disease Control, Atlanta, Georgia
- Irving G. Kagan**
Chief, Parasitology Branch, Bureau of Laboratories, Center for Disease Control, Atlanta, Georgia
- A. G. Karlson**
The Mayo Clinic, Rochester, Minnesota
- Leo Kaufman**
Chief, Fungus Immunology Section, Mycology Branch, Center for Disease Control, Atlanta, Georgia
- Douglas S. Kellogg**
Chief, Venereal Disease Research Branch, Center for Disease Control, Atlanta, Georgia
- Richard T. Kelly**
Pathologist, Microbiology Section, Department of Pathology, Baptist Memorial Hospital; and Assistant Professor, Departments of Microbiology and Pathology, University of Tennessee Medical Units, Memphis, Tennessee
- George E. Kenny**
Department of Pathobiology, University of Washington, School of Public Health, Seattle, Washington
- Arden H. Killinger**
Associate Professor, Department of Pathology and Hygiene, College of Veterinary Medicine, University of Illinois at Urbana-Champaign, Urbana, Illinois
- Franklin P. Koontz**
State Hygienic Laboratory, University of Iowa, Iowa City, Iowa
- George P. Kubica**
Trudeau Institute, Inc., Immunobiological Research Laboratories, Saranac Lake, New York
- Howard W. Larsh**
Chairman and Research Professor of Microbiology, Associate Director of Laboratories,

- University of Oklahoma, Norman, Oklahoma; and Associate Director of Laboratories, Missouri State Chest Hospital, Mount Vernon, Missouri*
- Edwin H. Lennette**
Chief, Biomedical Laboratories, and Chief, Viral and Rickettsial Disease Laboratory, California Department of Health, Berkeley, California
- Donald C. Mackel**
Deputy Chief, Epidemiologic Services, Laboratory Branch, Bacterial Diseases Division, Bureau of Epidemiology, Center for Disease Control, Atlanta, Georgia
- Robert L. Magoffin**
Assistant Chief, Viral and Rickettsial Disease Laboratory, California Department of Health, Berkeley, California
- George F. Mallison**
Assistant Director, Bacterial Diseases Division, Bureau of Epidemiology, Center for Disease Control, Atlanta, Georgia
- William J. Martin**
Chief, Microbiology Section, Clinical Laboratories, UCLA Hospital and Clinics; and Adjunct Associate Professor of Pathology and Medical Microbiology and Immunology, UCLA School of Medicine, The Center for the Health Sciences, Los Angeles, California
- John M. Matsen**
Associate Professor of Laboratory Medicine and Pathology, Pediatrics, and Microbiology; and Director, Clinical Microbiology Laboratories, University of Minnesota Hospitals, Minneapolis, Minnesota
- Joseph L. Melnick**
Professor of Virology and Epidemiology, and Chairman of Department, Department of Virology and Epidemiology, Baylor University, College of Medicine, Houston, Texas
- Joseph H. Miller**
Professor of Medical Parasitology, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana
- James H. Nakano**
Chief, Viral Vaccine Investigations Section, Virology Branch, Bureau of Laboratories, Head, WHO International Reference Center for Smallpox, Center for Disease Control, Atlanta, Georgia
- Harry S. Nielsen, Jr.**
Director, Allermed Laboratories, Inc., San Diego, California
- Lois G. Norman**
Research Microbiologist, Parasitology Branch, Center for Disease Control, Atlanta, Georgia
- Richard A. Ormsbee**
Rocky Mountain Laboratory, Hamilton, Montana
- Arvind A. Padhye**
Acting Chief, Fungus Reference Section, Center for Disease Control, Atlanta, Georgia
- George Paik**
Medical Microbiologist, General Hospital Microbiology Laboratory, Los Angeles County—University of Southern California Medical Center, Los Angeles, California
- Barbara J. Painter**
Long Island Jewish-Hillside Medical Center, New Hyde Park, New York
- Donald A. Person**
Assistant Professor of Virology and Epidemiology, Assistant Professor of Medicine, Baylor College of Medicine, Texas Medical Center, Houston, Texas
- Charles Alan Phillips**
Professor of Medicine, Department of Medicine, University of Vermont, Burlington, Vermont
- Bertie Pittman**
Analytical Bacteriology Branch, Center for Disease Control, Atlanta, Georgia

Bernard Portnoy

Professor, Pediatrics, Community Medicine and Public Health, University of Southern California School of Medicine; and Assistant Medical Director, Los Angeles County—USC Medical Center, Los Angeles, California

William E. Rawls

Professor of Virology and Epidemiology, Department of Virology and Epidemiology, Baylor College of Medicine, Houston, Texas

Gerbert C. Rebell

Research Associate, Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami School of Medicine, Miami, Florida

Oscar W. Richards

Pacific University, College of Optometry, Forest Grove, Oregon

Morrison Rogosa

Microbiologist, National Institute of Dental Research, Bethesda, Maryland

Leon Rosen

Head, Pacific Research Section, National Institute of Allergy and Infectious Diseases, Honolulu, Hawaii

Jon E. Rosenblatt

Assistant Chief, Infectious Disease Section, Wadsworth VA Hospital Center and Assistant Professor of Medicine, UCLA School of Medicine, Los Angeles, California

Ernest H. Runyon

VA Hospital, Salt Lake City, Utah

Ruth L. Russell

Professor, Microbiology Department, California State University, Long Beach, California; and Consultant Microbiologist, Memorial Hospital Medical Center, Long Beach, California

L. D. Sabath

Associate Professor of Medicine, Harvard Medical School; and Associate Visiting Physician, Boston City Hospital, Boston, Massachusetts

Margaret A. Salvatore

Research Associate in Pediatrics, Community Medicine and Public Health, University of Southern California School of Medicine, Chief Research Analyst, Los Angeles County—USC Medical Center, Los Angeles, California

Julius Schachter

Co-Director, WHO International Reference Centre for Trachoma and Other Chlamydial Infections, 1699-D, HSW, G. W. Hooper Foundation, University of California, San Francisco, California

Jack H. Schieble

Research Specialist, Viral and Rickettsial Disease Laboratory, California Department of Health, Berkeley, California

Nathalie J. Schmidt

Research Specialist, Viral and Rickettsial Disease Laboratory, California Department of Health, Berkeley, California

John D. Schneidau, Jr.

Professor of Medical Mycology, Department of Microbiology and Immunology; and Mycologist, Ochsner Foundation Hospital, Tulane University School of Medicine, New Orleans, Louisiana

Smith Shadomy

Associate Professor of Medicine and Microbiology, Medical College of Virginia, Virginia Commonwealth University, Richmond, Virginia

John C. Sherris

Professor and Chairman, Department of Microbiology, University of Washington, Seattle, Washington

Robert E. Shope

Director, Yale Arbovirus Research Unit, Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, Connecticut

Grace J. Shramek

Director of Microbiology, St. Francis Hospital, Evanston, Illinois

Margarita Silva-Hutner

Associate Professor and Director, Mycology Laboratory, Columbia University College of Physicians & Surgeons, and Columbia-Presbyterian Medical Center, New York, New York

Louis D.S. Smith

Professor of Microbiology, Anaerobe Laboratory, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Alex C. Sonnenwirth

Director, Division of Microbiology, The Jewish Hospital of St. Louis; and Associate Professor, Departments of Microbiology and Pathology, Washington University School of Medicine, The Jewish Hospital of St. Louis, St. Louis, Missouri

Earle H. Spaulding

Professor of Microbiology and Immunology, School of Medicine, Temple University Health Sciences Center, Philadelphia, Pennsylvania

Marlene Stahl

Chief Technician, Pediatric Virus Laboratory, Department of Pediatrics, University of Arizona, Arizona Medical Center, Tucson, Arizona

Morris T. Suggs

Chief, Biological Products Division, Center for Disease Control, Atlanta, Georgia

Hiroshi Sugiyama

Professor, Food Research Institute, University of Wisconsin, Madison, Wisconsin

Vera L. Sutter

Director, Anaerobic Bacteriology Laboratory, Research Service, Wadsworth Hospital Center, Veterans Administration; and Adjunct Associate Professor, UCLA School of Medicine, Los Angeles, California

J. Clyde Swartzwelder

Professor of Medical Parasitology, and Head, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana

Harvey W. Tatum

Research Microbiologist, Bacterial Reference Unit, Bacteriology Branch, Center for Disease Control, Atlanta, Georgia

Bernard V. Travis

Emeritus Professor, Department of Entomology, Cornell University, Ithaca, New York

Joseph P. Truant

Director of Microbiology-Immunology, Advance Medical and Research Center, Pontiac, Michigan; Adjunct Professor, Department of Microbiology and Public Health, Michigan State University, Lansing, Michigan; Director of Microbiology, Wayne County Respiratory Disease Control Division, Wayne County, Michigan

Jerome P. Vanderberg

Associate Professor, Department of Preventive Medicine, New York University School of Medicine, New York, New York

Harriette D. Vera

BioQuest Division, Becton, Dickinson and Co., Cockeysville, Maryland

Lionel G. Warren

Associate Professor of Medical Parasitology, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana

John A. Washington II

Head, Section of Clinical Microbiology, Mayo Clinic; and Associate Professor, Departments of Microbiology and Laboratory Medicine, Mayo Medical School, Rochester, Minnesota

Lawrence G. Wayne

Tuberculosis Research Laboratory, VA Hospital, Long Beach, California

Robert E. Weaver

Chief, Special Bacteriology Unit, Clinical Bacteriology Section, Bacteriology Branch, Center for Disease Control, Atlanta, Georgia

Ronald M. Wood

Chief, Microbial Diseases Laboratory, Division of Laboratories, California Department of Health, Berkeley, California

Viola M. Young

Clinical Branch, National Cancer Institute, Baltimore, Maryland

Robert E. Shope
Grace J. Stranick
Director of Microbiology, St. Francis Hospital, Evanston, Illinois
Margaret Silver-Hahn
Associate Professor and Director, Mycology Laboratory, Columbia University
Louis D.S. Smith
Alex C. Sosenow
Director, Division of Microbiology and Pathology, Washington University School of Medicine, The Jewish Hospital of St. Louis, St. Louis, Missouri
Earle H. Spaulding
Professor of Microbiology and Immunology, School of Medicine, Temple University Health Sciences Center, Philadelphia, Pennsylvania
Martine Stahl
Chief Technician, Pediatric Virus Laboratory, Department of Pediatrics, University of Arizona, Tucson, Arizona
Morris T. Suggs
Chief, Biological Products Division, Center for Disease Control, Atlanta, Georgia
Hiroshi Saitama
Professor, Food Research Institute, University of Wisconsin, Madison, Wisconsin
Vera L. Sutter
Director, Anaerobic Bacteriology Laboratory, Research Service, Wadsworth Hospital Center, Veterans Administration, and Adjunct Associate Professor, UCLA School of Medicine, Los Angeles, California
J. Clyde Swartzwelder
Professor of Medical Parasitology and Head, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana
Harvey W. Tatum
Research Microbiologist, Bacterial Reference Unit, Bacteriology Branch, Center for Disease Control, Atlanta, Georgia
Bernard V. Tavis
Emeritus Professor, Department of Entomology, Cornell University, Ithaca, New York
Joseph P. Tarrant
Director of Microbiology-Immunology, Advance Medical and Research Center, Pontiac, Michigan, Adjunct Professor, Department of Microbiology and Public Health, Michigan State University, Lansing, Michigan; Director of Microbiology, Wayne County Respiratory Disease Control Division, Wayne County, Michigan
Jerome P. Vanderberg
Associate Professor, Department of Preventive Medicine, New York University School of Medicine, New York, New York
Hazellette D. Vets
BioQuest Division, Barton, Dickinson and Co., Cockeysville, Maryland
Lionel G. Warren
Associate Professor of Medical Parasitology, Department of Tropical Medicine and Medical Parasitology, Louisiana State University Medical Center, New Orleans, Louisiana

PREFACE TO SECOND EDITION

This edition represents a continuing effort by the American Society for Microbiology to provide practicing clinical laboratory microbiologists with a *useful manual*. The authors were selected for their extensive, and sometimes unique, knowledge of and experience in their subject areas. The large majority of chapters were peer reviewed, some by coauthors of the same chapter, others by one or more authors of other chapters, and a few by special non-author reviewers.

Since the publication of the first edition in 1970, the acquisition of knowledge, as well as the development of new and improved methods in clinical microbiology, has continued at a constantly accelerating rate. A primary objective of the editors is to keep pace with this process in relevant areas, and they support the policy of the ASM Publications Board which proposes to publish new editions at frequent intervals. Nevertheless, a publication lag is inevitable and unavoidable. Consequently, we welcome the addition of *Cumitechs* as a promising effort to fill this gap.

To a very large extent this edition consists of either extensively revised chapters or entirely new material. A few chapters in the first edition were combined in this one, incorporated into other chapters, or reduced in content to make room for topics of more current importance. Greatly expanded were the following subject areas: collection and transport of specimens, the anaerobic bacteria, control of hospital infections, laboratory tests in chemotherapy, and hepatitis and EB viruses. On the other hand, the section on immunoserological tests was only modestly enlarged because the ASM plans to publish a companion *Manual of Clinical Immunology* in the near future.

We, the co-editors, thank the 125 authors for the generally high quality of their material and for acceptance of the peer review procedure. We are indebted to the other 10 members of the Editorial Board for, as Section Editors, their responsibilities required very heavy commitments of time and effort. It was they, for example, who saw that authors prepared their chapters in accordance with the primary charge "... to provide a working and teaching guide that will be of practical use in the daily routine of the clinical laboratory, and also serve the needs of the student and teacher of clinical microbiology."

A special contribution to the format and content of this edition was made by an ad hoc committee chaired by John C. Sherris; its comprehensive critique of the first edition was the framework for this edition.

Finally, we express our appreciation for the courtesies, patience and cooperation that consistently characterized our treatment by Gisella Pollock, Estella Bradley, and Margaret Miller of Robert A. Day's staff in the ASM Publications Office.

Edwin H. Lennette
Earle H. Spaulding
Joseph P. Truant

3 May 1974

130	12. <i>Corynebacterium</i>	12
132	13. <i>Listeria monocytogenes</i>	13
140	14. <i>Erysipelothrix</i>	14
143	15. <i>Bacillus anthracis</i>	15
148	16. <i>Mycobacterium</i>	16
172	17. Aerobic Pathogenic Actinomycetaceae	172
182	18. Eristobacteriaceae	182
222	19. <i>Yersinia</i>	222
230	20. <i>Aeromonas</i>	230
238	21. <i>Vibrio</i>	238
246	22. <i>Pasteurella</i>	246
250	23. <i>Pseudomonas</i>	250
270	24. Miscellaneous Gram-Negative Bacteria	270
292	25. <i>Bordetella</i>	292
302	26. <i>Haemophilus</i>	302
308	27. <i>Bordetella</i>	308
316	28. <i>Francisella tularensis</i>	316
320	29. <i>Campylobacter</i>	320
323	30. <i>Comamonad</i>	323
326	31. <i>Mycobacterium</i>	326
333	32. <i>Mycobacterium</i>	333
338	33. <i>Corynebacterium</i>	338
	Section I	
	GENERAL	
	1. Introduction. JOSEPH P. TRUANT	3
	2. Classification and Nomenclature of Bacteria. JOSEPH P. TRUANT	6
	3. Microscopy. OSCAR W. RICHARDS	10
	4. Immunofluorescence Techniques. WILLIAM B. CHERRY	29
	5. Indigenous and Pathogenic Microorganisms of Man. HENRY D. ISENBERG and BARBARA G. PAINTER	45
	6. Collection, Handling, and Processing of Specimens. HENRY D. ISENBERG, JOHN A. WASHINGTON II, ALBERT BALOWS, and ALEX C. SONNENWIRTH	59
	A. Introduction	59
	B. Collection of Specimens	59
	Anatomic and surgical pathology	59
	Blood cultures	61
	Ear	63
	Eye	63
	Feces	63
	Fluids, body	64
	Respiratory tract	66
	Urine	68
	Venereal disease	70
	Wounds	71
	C. Transport of Specimens to the Laboratory	72
	D. Recording of Laboratory Specimens	73
	E. Preparation of Specimens for Primary Culturing	74
	F. Inoculation of Media and Colony Isolation Methodology	75
	G. Media for Primary Isolation	78
	H. Incubation of Inoculated Media	78
	I. Examination of Cultures for Presumptive Recognition and Identification of Isolates	79
	Section II	
	AEROBIC BACTERIA	
	7. <i>Staphylococcus</i> . DANIEL IVLER	91
	8. <i>Streptococci</i> . RICHARD R. FACKLAM	96
	9. <i>Streptococcus pneumoniae</i> (Pneumococcus). ROBERT AUSTRIAN	109
	10. <i>Neisseria meningitidis</i> (Meningococcus). B. WESLEY CATLIN	116
	11. <i>Neisseria gonorrhoeae</i> (Gonococcus). DOUGLAS S. KELLOG, JR.	124

12. <i>Corynebacterium</i> . GEORGE J. HERMANN and S. T. BICKMAN	130
13. <i>Listeria monocytogenes</i> . ARDEN H. KILLINGER	135
14. <i>Erysipelothrix</i> . ROBERT E. WEAVER	140
15. <i>Bacillus anthracis</i> . JAMES C. FEELEY and PHILIP S. BRACHMAN	143
16. <i>Mycobacterium</i> . ERNEST H. RUNYON, A. G. KARLSON, GEORGE P. KUBICA, and LAWRENCE G. WAYNE	148
17. Aerobic Pathogenic <i>Actinomycetaceae</i> . MORRIS A. GORDON	175
18. <i>Enterobacteriaceae</i> . WILLIAM H. EWING and WILLIAM J. MARTIN	189
19. <i>Yersinia</i> . ALEX C. SONNENWIRTH	222
20. <i>Aeromonas</i> . WILLIAM H. EWING and RUDOLPH HUGH	230
21. <i>Vibrio</i> . JOHN C. FEELEY and ALBERT BALOWS	238
22. <i>Pasteurella</i> . GEORGE H. G. EISENBERG, JR., and DAN C. CAVANAUGH	246
23. <i>Pseudomonas</i> . RUDOLPH HUGH and GERALD L. GILARDI	250
24. Miscellaneous Gram-Negative Bacteria. HARVEY W. TATUM, WILLIAM H. EWING, and ROBERT E. WEAVER	270
25. <i>Brucella</i> . W.J. HAUSLER, JR., and F.P. KOONTZ	295
26. <i>Haemophilus</i> . VIOLA M. YOUNG	302
27. <i>Bordetella</i> . B. PITTMAN	308
28. <i>Francisella tularensis</i> . HENRY T. EIGELSBACH	316
29. <i>Actinobacillus</i> . AARON D. ALEXANDER	320
30. <i>Calymmatobacterium granulomatis</i> . DOUGLAS S. KELLOGG, JR.	323
31. <i>Streptobacillus moniliformis</i> and <i>Spirillum minor</i> . MORRISON ROGOSA	326
32. <i>Mycoplasma</i> . GEORGE E. KENNY	333
33. Cell Wall-Defective Bacteria. THOMAS R. CATE	338

Section III SPIROCHETES

34. <i>Leptospira</i> . AARON D. ALEXANDER	347
35. <i>Borrelia</i> . RICHARD T. KELLY	355
36. <i>Treponema</i> . RICHARD T. KELLY	358

Section IV ANAEROBIC BACTERIA

37. Introduction to Anaerobic Bacteria. LOUIS DS. SMITH	363
38. Isolation of Anaerobic Bacteria. SYDNEY M. FINEGOLD, VERA L. SUTTER, HOWARD R. ATTEBERY, and JON E. ROSENBLATT	365
39. <i>Clostridium</i> . LOUIS DS. SMITH and V. R. DOWELL, JR.	376
40. Anaerobic Cocci. WILLIAM J. MARTIN	381
41. Gram-Negative Nonsporeforming Anaerobic Bacilli. VERA L. SUTTER, HOWARD R. ATTEBERY, and SYDNEY M. FINEGOLD	388
42. Gram-Positive Nonsporeforming Anaerobic Bacilli. V. R. DOWELL, JR., and ALEX C. SONNENWIRTH	396
43. Anaerobic Blood Cultures. JOHN A. WASHINGTON II	402

Section V
LABORATORY TESTS IN CHEMOTHERAPY

44. Introduction. JOHN C. SHERRIS 407

45. Dilution Test Procedures. JOHN A. WASHINGTON II and ARTHUR L. BARRY 410

46. Diffusion Test Procedures. JOHN M. MATSEN and ARTHUR L. BARRY 418

47. Assay of Antimicrobial Agents. L. D. SABATH and JOHN M. MATSEN 428

48. Special Tests: Bactericidal Activity and Activity of Antimicrobics in Combination.
 ARTHUR L. BARRY and L. D. SABATH 431

49. Susceptibility Testing of Anaerobes. VERA L. SUTTER and JOHN A. WASHINGTON II 436

50. Future Needs. JOHN C. SHERRIS 439

Appendix 1—MIC Values. ARTHUR L. BARRY 441

Appendix 2—Serum Concentrations. L. D. SABATH 442

Section VI

IMMUNOSEROLOGICAL TESTS

51. Tests for Syphilis. RONALD M. WOOD 445

52. Immunoserological Tests Other Than Syphilis. WALLIS L. JONES 455

 A. Agglutinations, Febrile 455

 B. Antinuclear Antibody 455

 C. Antistreptolysin O Microtitration Test 456

 D. Diphtheria and Tetanus Antitoxin Levels 456

 E. Immunoglobulin Determinations 457

 F. Infectious Mononucleosis: Laboratory Methods for Diagnosis 457

 G. Leptospirosis Serology 458

 H. Listeria Serology 459

 I. Rheumatoid Factor 459

 J. Streptococcal Serology 460

Section VII

FUNGI

53. Introduction to Clinical Mycology. B. H. COOPER 463

54. Dermatophytes and the Agents of Superficial Mycoses. LIBERO AJELLO and ARVIND
 A. PADHYE 469

55. Fungi of Keratomycosis. GERBERT C. REBELL and RICHARD K. FORSTER 482

56. Medically Important Yeasts. MARGARITA SILVA-HUTNER and B. H. COOPER 491

57. Fungi of Systemic Mycoses. HOWARD W. LARSH and NORMAN L. GOODMAN 508

58. Fungi of Maduromycosis. JOHN D. SCHNEIDAU, JR. 522

59. Dematiaceous Fungi. HARRY S. NIELSEN, JR. 528

60. Fungi of Phycomycosis. DONALD L. GREER 541

61. Medically Important *Aspergillus* Species. PETER K. C. AUSTWICK 550

62. Serodiagnosis of Fungal Diseases. LEO KAUFMAN 557

63. Susceptibility Testing of Antifungal Agents. SMITH, SHADOMY and ANA ESPINEL-INGROFF 569

407 Introduction JOHN C. SHERRIS 44

410 Diffusion Test Procedures JOHN A. WASHINGTON II and ARTHUR L. BARRY 45

418 Diffusion Test Procedures JOHN M. MATSEN and ARTHUR L. BARRY 46

428 Assay of Antimicrobial Agents L. B. FLETCHER and JOHN M. MATSEN 47

Section VIII
PARASITES

48. Special Tests: Bactericidal Activity of Antimicrobials in Combination. ARTHUR L. BARRY and J. D. SABATH 48

64. Clinical Parasitology: Introduction and General Methods. J. CLYDE SWARTZWELDER 577

65. Intestinal and Urogenital Protozoa. MARION M. BROOKE 582

66. Soil Amoeba Infection. CLYDE G. CULBERTSON 602

67. Blood and Hematopoietic Parasites. JOSEPH H. MILLER, LIONEL G. WARREN, STANLEY H. ABADIE, and J. CLYDE SWARTZWELDER 605

68. Helminths. STANLEY H. ABADIE, JOSEPH H. MILLER, LIONEL G. WARREN, J. CLYDE SWARTZWELDER, and MARK R. FELDMAN 617

69. Arthropods Affecting Humans. JEROME P. VANDERBERG and BERNARD V. TRAVIS 636

70. Serodiagnosis of Parasitic Diseases. IRVING G. KAGAN and LOIS NORMAN 645

Section VI
IMMUNOSEROLOGICAL TESTS

442 Tests for Syphilis. RONALD M. WOOD 51

452 Immunoserological Tests Other Than Syphilis. WALLIS L. JONES 52

Section IX
VIRUSES AND RICKETTSIAE

456 Clinical Virology: Introduction to Methods. EDWIN H. LENNETTE, JOSEPH L. MELNICK, and ROBERT L. MAGOFFIN 667

457 Influenza Virus. WALTER R. DOWDLE and MARION T. COLEMAN 678

459 Parainfluenza and Respiratory Syncytial Viruses. VINCENT A. FULGINITI and MARLENE STAHL 686

462 Adenoviruses. BERNARD PORTNOY and MARGARET A. SALVATORE 695

463 Mumps Virus. FRIEDRICH W. DEINHARDT and GRACE J. SHRAMEK 703

464 Measles Virus. FRANCIS L. BLACK 709

465 Rubella Virus. WILLIAM E. RAWLS and DONALD A. PERSON 716

466 Enteroviruses. C. A. PHILLIPS 723

467 Rhinoviruses. JACK H. SCHIEBLE 728

468 Reoviruses. LEON ROSEN 735

469 Arboviruses. ROBERT E. SHOPE 740

470 Rabiesvirus. HARALD NORLIN JOHNSON 746

471 Herpes Simplex Virus. ERNEST C. HERRMANN, JR., and WILLIAM E. RAWLS 754

472 Human Cytomegalovirus. MATILDA BENYESH-MELNICK 762

473 Varicella-Zoster Virus. NATHALIE J. SCHMIDT 773

474 Smallpox, Vaccinia, and Human Infections with Monkeypox Viruses. JAMES H. NAKANO and PATRICIA G. BINGHAM 782

475 Chlamydiae (Psittacosis-Lymphogranuloma Venereum-Trachoma Group). VELLE HANNA, JULIUS SCHACHTER, and ERNEST JAWETZ 795

476 Rickettsiae. RICHARD A. ORMSBEE 805

477 EB Herpesvirus. PAUL GERBER 816

478 Hepatitis Viruses. F. BLAINE HOLLINGER 819

479 90A. Classification of Viruses. JOSEPH L. MELNICK 834