



# MANUAL OF CLINICAL MICROBIOLOGY

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FOURTH EDITION

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## Preface

The first edition of the *Manual of Clinical Microbiology* was published in 1970. In 15 years the Manual has appeared in four editions, each extensively revised to provide readers and workers with an authoritative and useful volume for the bench and the classroom which would be as up to date as current publication methods would permit. The format developed over the years to achieve this purpose has earned the Manual wide acclaim and increasing distribution, both nationally and internationally.

The Editors of this fourth edition were mindful of past success as they undertook the planning and structuring of the book and the selection of the Editorial Board. The authors selected are experts in their respective fields who were willing to give of their time to write chapters representing the best information currently available for clinical, medical, and public health microbiologists and virologists. Each chapter is presented with the assurance that the methods, reagents, and guidance provided are both time tested and completely up to date.

The Editors, the Editorial Board, and the authors have had one guiding principle: to produce a reliable, current, and convenient manual for clinical and public health microbiologists. To achieve these objectives, the Editors retained the general format that has been used in previous editions. Changes have been made, however. Each chapter in the previous edition of the Manual was either thoroughly revised or completely rewritten. In addition, much new material has been added. Some of the new chapters cover automation and rapid diagnostic methods, computer utilization, surveillance and control of nosocomial infections, anaerobic spirochetes, parvoviruses, papovaviruses, and T-cell leukemia viruses. New sections on molecular methods and sexually transmitted diseases have been added. The previous section on immunoserological tests has been completely restructured into a state-of-the-art unit on immunodiagnostic tests, as have the chapters dealing with antimicrobial susceptibility testing. The section on media, reagents, and stains also has been recast and should prove to be of continuing use to the reader.

The Editors recognize that this fourth edition of the *Manual of Clinical Microbiology* would not have been possible without the capable input of the excellent Editorial Board and authors, who all contributed generously of their time, knowledge, and expertise to make this book a reality. The Editors thank the staff of the ASM Publications Department, including Walter Peter, Susan Birch, Ellie Tupper, Sara Joslyn, and Marie Smith, who held up remarkably well under the stress and strain of missed deadlines and were always helpful and facilitative. We are also most grateful to the many individuals who participated in the peer review process to assist us in reaching our goal.

Finally, we express our indebtedness to our secretaries and those of the many authors, who produced several versions of typescript to the satisfaction of the authors, Editorial Board members, reviewers, and Editors. Our burden was lighter and the task more pleasant in this collaborative effort with so many dedicated and cooperative people.

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# Contents

Editorial Board.....	ix
Contributors.....	x-xvi
Preface.....	xvii

## Section I. GENERAL

Section Editor: Henry D. Isenberg

1. Taxonomy, Classification, and Nomenclature of Bacteria. DON J. BRENNER.....	1
2. Microscopy. STEVEN D. DOUGLAS.....	8
3. Quality Control in Clinical Microbiology. RAYMOND C. BARTLETT.....	14
4. Indigenous and Pathogenic Microorganisms of Humans. HENRY D. ISENBERG AND RICHARD F. D'AMATO.....	24
5. Procedures to Use During Outbreaks of Food-Borne Disease. FRANK L. BRYAN.....	36
6. Rapid and Mechanized/Automated Systems in Microbiology. RICHARD F. D'AMATO, JAMES C. MCLAUGHLIN, AND MARY JANE FERRARO.....	52
7. Computers in Clinical Microbiology. JAMES D. MACLOWRY AND KENNETH J. RYAN.....	66
8. Collection, Handling, and Processing of Specimens. HENRY D. ISENBERG, JOHN A. WASHINGTON II, ALBERT BALOWS, AND ALEX C. SONNENWIRTH.....	73

## Section II. NOSOCOMIAL INFECTION PREVENTION AND CONTROL

Section Editor: James M. Hughes

9. Epidemiology of Nosocomial Infections. JAMES M. HUGHES AND WILLIAM R. JARVIS.....	99
10. Nosocomial Infection Surveillance and Control Programs. JULIA S. GARNER AND T. GRACE EMORI.....	105
11. Role of the Microbiology Laboratory in Prevention and Control of Nosocomial Infections. JOHN E. MCGOWAN, JR.....	110
12. Infection Control Priorities in Critical Care Medicine: Device-Associated Intravascular Infections. RICHARD P. WENZEL.....	123
13. Sterilization, Disinfection, and Antisepsis in the Hospital. MARTIN S. FAVERO.....	129
14. Biological Safety in the Clinical Laboratory. JOHN H. RICHARDSON AND W. EMMETT BARKLEY.....	138

## Section III. AEROBIC BACTERIA

Section Editors: Marie B. Coyle, Josephine A. Morello, P. Byrd Smith

15. Staphylococci. W. E. KLOOS AND J. H. JORGENSEN.....	143
16. Streptococci and Aerococci. RICHARD R. FACKLAM AND ROBERTA B. CAREY.....	154
17. <i>Neisseria</i> and <i>Branhamella</i> . JOSEPHINE A. MORELLO, WILLIAM M. JANDA, AND MARJORIE BOHNHOFF.....	176
18. <i>Corynebacterium</i> spp. and Other Coryneform Organisms. MARIE B. COYLE, DANNIE G. HOLLIS, AND NEAL B. GROMAN.....	193
19. <i>Listeria</i> . ROBERT BORTOLUSSI, WALTER F. SCHLECH III, AND WILLIAM L. ALBRITTON.....	205
20. <i>Erysipelothrix</i> . ROBERT E. WEAVER.....	209
21. <i>Bacillus</i> . R. J. DOYLE, K. F. KELLER, AND J. W. EZZELL.....	211
22. <i>Mycobacterium</i> . HERBERT M. SOMMERS AND ROBERT C. GOOD.....	216
23. Aerobic Pathogenic <i>Actinomycetaceae</i> . MORRIS A. GORDON.....	249
24. <i>Enterobacteriaceae</i> . MICHAEL T. KELLY, DON J. BRENNER, AND J. J. FARMER III.....	263
25. <i>Aeromonas</i> and <i>Plesiomonas</i> . ALEXANDER VON GRAEVENITZ.....	278
26. <i>Vibrio</i> . J. J. FARMER III, F. W. HICKMAN-BRENNER, AND MICHAEL T. KELLY.....	282
27. <i>Campylobacter</i> . GEORGE K. MORRIS AND CHARLOTTE M. PATTON.....	302
28. Gram-Negative Fermentative Bacteria and <i>Francisella tularensis</i> . ROBERT E. WEAVER, DANNIE G. HOLLIS, AND EDWARD J. BOTTONE.....	309

29. Glucose-Nonfermenting Gram-Negative Bacteria. SALLY JO RUBIN, PAUL A. GRANATO, AND BENEDICT L. WASILAUSKAS.....	330
30. <i>Pseudomonas</i> . GERALD L. GILARDI .....	350
31. <i>Legionella</i> . PAUL H. EDELSTEIN .....	373
32. <i>Brucella</i> . W. J. HAUSLER, JR., N. P. MOYER, AND L. A. HOLCOMB.....	382
33. <i>Haemophilus</i> . MOGENS KILIAN.....	387
34. <i>Bordetella</i> . CHARLOTTE D. PARKER AND BEVERLEY J. PAYNE.....	394
35. <i>Streptobacillus moniliformis</i> and <i>Spirillum minus</i> . MORRISON ROGOSA.....	400
36. Mycoplasmas. GEORGE E. KENNY .....	407

#### Section IV. ANAEROBIC BACTERIA

Section Editor: Stephen D. Allen

37. Isolation and Examination of Anaerobic Bacteria. STEPHEN D. ALLEN, JEAN A. SIDERS, AND LINDA M. MARLER .....	413
38. <i>Clostridium</i> . STEPHEN D. ALLEN .....	434
39. Anaerobic Cocci. JON E. ROSENBLATT .....	445
40. Gram-Negative, Nonsporeforming Anaerobic Bacilli. SYDNEY M. FINEGOLD AND MARTHA A. C. EDELSTEIN.....	450
41. Gram-Positive, Nonsporeforming Anaerobic Bacilli. STEPHEN D. ALLEN .....	461

#### Section V. SPIROCHETES

Section Editor: Russell C. Johnson

42. <i>Leptospira</i> . AARON D. ALEXANDER .....	473
43. <i>Borrelia</i> . WILLY BURGENDORFER .....	479
44. <i>Treponema</i> . THOMAS J. FITZGERALD .....	485
45. Anaerobic Spirochetes. ROBERT M. SMIBERT .....	490

#### Section VI. FUNGI

Section Editor: Billy H. Cooper

46. Taxonomy, Classification, and Nomenclature of Fungi. BILLY H. COOPER .....	495
47. Detection and Recovery of Fungi in Clinical Specimens. GLENN D. ROBERTS, NORMAN L. GOODMAN, GEOFFREY A. LAND, HOWARD W. LARSH, AND MICHAEL R. MCGINNIS.....	500
48. Dermatophytes and the Agents of Superficial Mycoses. LIBERO AJELLO AND ARVIND A. PADHYE ...	514
49. Yeasts of Medical Importance. BILLY H. COOPER AND MARGARITA SILVA-HUTNER .....	526
50. Fungi of Systemic Mycoses. HOWARD W. LARSH AND NORMAN L. GOODMAN .....	542
51. Fungi Causing Eumycotic Mycetomas. ARVIND A. PADHYE AND LIBERO AJELLO.....	554
52. Dematiaceous Fungi. MICHAEL R. MCGINNIS .....	561
53. Agents of Zygomycosis (Phycomycosis). DONALD L. GREER AND ALVIN L. ROGERS .....	575
54. <i>Aspergillus</i> Species and Other Opportunistic Saprophytic Hyaline Hyphomycetes. FRANK E. SWATEK, CARLYN HALDE, MICHAEL G. RINALDI, AND H. JEAN SHADOMY.....	584

#### Section VII. PARASITES

Section Editor: James W. Smith

55. Diagnostic Parasitology: Introduction and Methods. JAMES W. SMITH AND MARILYN S. BARTLETT .....	595
56. Blood and Tissue Protozoa. DONALD J. KROGSTAD, GOVINDA S. VISVESVARA, KENNETH W. WALLS, AND JAMES W. SMITH .....	612
57. Intestinal and Urogenital Protozoa. DOROTHY M. MELVIN AND GEORGE R. HEALY .....	631
58. Tissue Helminths. THOMAS C. ORIHIEL AND LAWRENCE R. ASH .....	651
59. Intestinal Helminths. LAWRENCE R. ASH AND THOMAS C. ORIHIEL .....	660
60. Arthropods of Medical Importance. HARRY D. PRATT AND JAMES W. SMITH.....	674

**Section VIII. VIRUSES, RICKETTSIAE, AND CHLAMYDIAE**

Section Editor: C. George Ray

61. Collection and Preparation of Specimens for Virological Examination. DAVID A. LENNETTE .....	687
62. Taxonomy of Viruses. JOSEPH L. MELNICK .....	694
63. Adenoviruses. MARION K. COONEY .....	701
64. Herpes Simplex Viruses. W. LAWRENCE DREW AND WILLIAM E. RAWLS .....	705
65. Human Cytomegalovirus. STUART E. STARR AND HARVEY M. FRIEDMAN .....	711
66. Varicella-Zoster Virus. NATHALIE J. SCHMIDT .....	720
67. Epstein-Barr Virus. EVELYNE T. LENNETTE .....	728
68. Poxviruses. JAMES H. NAKANO .....	733
69. Reoviruses. MARILYN A. MENEGUS .....	742
70. Enteroviruses. MARILYN A. MENEGUS .....	743
71. Rhinoviruses and Coronaviruses. JACK H. SCHIEBLE .....	747
72. Influenza Viruses. ALAN P. KENDAL, WALTER R. DOWDLE, AND GARY R. NOBLE .....	755
73. Parainfluenza and Respiratory Syncytial Viruses. KENNETH MCINTOSH AND JULIA C. CLARK .....	763
74. Measles Virus. ERLING NORRBY .....	769
75. Mumps Virus. ERLING NORRBY .....	774
76. Rubella Virus. KENNETH L. HERRMANN .....	779
77. Arboviruses. ROBERT E. SHOPE .....	785
78. Rabies Virus. GEORGE M. BAER AND JEAN S. SMITH .....	790
79. Marburg Virus, Ebola Virus, and the Arenaviruses. PETRA B. JAHALING .....	796
80. Viral Gastroenteritis Agents. NEIL R. BLACKLOW AND GEORGE CUKOR .....	805
81. Hepatitis Viruses. F. BLAINE HOLLINGER AND JULES L. DIENSTAG .....	813
82. Human Parvoviruses and Papovaviruses. LINDA L. MINNICH AND C. GEORGE RAY .....	836
83. Human T-Cell Leukemia Viruses. M. ESSEX .....	840
84. Rickettsiae. RICHARD A. ORMSBEE .....	845
85. Chlamydiae (Psittacosis-Lymphogranuloma Venereum-Trachoma Group). JULIUS SCHACHTER .....	856

**Section IX. SEXUALLY TRANSMITTED DISEASES**

Section Editor: Stephen A. Morse

86. Sexually Transmitted Diseases. STEPHEN A. MORSE AND SAMUEL K. SARAFIAN .....	863
87. <i>Haemophilus ducreyi</i> and <i>Calymmatobacterium granulomatis</i> . WILLIAM L. ALBRITTON, FRANK A. PLUMMER, FRANCES O. SOTTNECK, AND STEPHEN J. KRAUS .....	869
88. <i>Gardnerella vaginalis</i> . PETER PIOT .....	874

**Section X. IMMUNODIAGNOSTIC TESTS**

Section Editor: Richard C. Tilton

89. Specific Immunoglobulin Detection. RAYMOND W. RYAN AND IRENE KWASNIK .....	877
90. Detection of Bacterial Antigens by Counterimmunoelectrophoresis, Coagglutination, and Latex Agglutination. JOAN C. FUNG AND RICHARD C. TILTON .....	883
91. Immunofluorescence Microscopy. ROGER M. MCKINNEY AND WILLIAM B. CHERRY .....	891
92. Immunology of Bacterial Infections. SILAS O. PARMER .....	898
93. Monoclonal Antibodies in Clinical Microbiology. MILTON R. TAM, LYNN C. GOLDBEIN, AND DALE E. YELTON .....	905
94. Serologic Tests for Syphilis. LYNDY L. BRADFORD AND SANDRA A. LARSEN .....	910
95. Viral Serology. KENNETH L. HERRMANN .....	921
96. Serodiagnosis of Fungal Diseases. LEO KAUFMAN AND ERROL REISS .....	924
97. Serodiagnostic Tests for Parasitic Diseases. KENNETH W. WALLS .....	945
98. Solid-Phase Enzyme Immunoassays for the Detection of Microbial Antigens in Body Fluids. ROBERT H. YOLKEN .....	949

**Section XI. LABORATORY TESTS IN CHEMOTHERAPY**

Section Editor: Clyde Thornsberry

99. General Considerations. CLYDE THORNSBERRY AND JOHN C. SHERRIS .....	959
100. Susceptibility Tests: Agar Dilution. JOHN A. WASHINGTON II .....	967
101. Susceptibility Tests: Microdilution and Macrodilution Broth Procedures. RONALD N. JONES, ARTHUR L. BARRY, THOMAS L. GAVAN, AND JOHN A. WASHINGTON II .....	972
102. Susceptibility Tests: Diffusion Test Procedures. ARTHUR L. BARRY AND CLYDE THORNSBERRY .....	978
103. Susceptibility Testing of Anaerobes. VERA L. SUTTER .....	988
104. Laboratory Studies with Antifungal Agents: Susceptibility Tests and Bioassays. SMITH SHADOMY, ANA ESPINEL-INGROFF, AND RODNEY Y. CARTWRIGHT .....	991
105. Susceptibility Tests: Special Tests. F. D. SCHOENKNECHT, L. D. SABATH, AND C. THORNSBERRY .....	1000
106. Assays for Antimicrobial Agents in Body Fluids. JOHN P. ANHALT .....	1009
107. Automated Procedures for Antimicrobial Susceptibility Tests. CLYDE THORNSBERRY .....	1015
Appendix 1. Preparation and Storage of Antimicrobial Solutions. JOHN P. ANHALT AND JOHN A. WASHINGTON II .....	1019
Appendix 2. Approximate Concentration of Antimicrobial Agents Achieved in Blood. CLYDE THORNSBERRY AND L. D. SABATH .....	1021

**Section XII. MOLECULAR METHODS**

Section Editor: John C. Feeley

108. DNA Methods in Clinical Microbiology. LUCY S. TOMPKINS .....	1023
109. Uses of Gas-Liquid Chromatography and High-Pressure Liquid Chromatography in Clinical Mi- crobiology. C. WAYNE MOSS .....	1029

**Section XIII. MEDIA, REAGENTS, AND STAINS**

Section Editor: Peter Nash

110. Quality Control of Media. JOHN E. FORNEY AND J. MICHAEL MILLER .....	1037
111. Culture Media. ELIZABETH PHILLIPS AND PETER NASH .....	1051
112. Reagents and Stains. DONALD A. HENDRICKSON .....	1093
Author Index .....	1109
Subject Index .....	1110



## Section I. General

# Taxonomy, Classification, and Nomenclature of Bacteria

DON J. BRENNER

Medical textbooks are the last place to look for definitive taxonomic data. Medical sources are historically the most conservative in keeping abreast of changes in taxonomy and nomenclature. Such nomenclatural anachronisms as "*Vibrio comma*," "noncholera vibrio," and "*Salmonella typhosa*" are examples of the ultraconservative approach of some medical sources to changes in nomenclature.

The most comprehensive treatment of bacterial classification, particularly for nomenclature, type strains, description of taxa, and references to pertinent literature, is found in *Bergey's Manual of Systematic Bacteriology*, vol. 1, and in *Bergey's Manual of Determinative Bacteriology*, 8th ed. (2, 8). These are invaluable reference sources and should be at the desk of every microbiologist. The 8th edition of *Bergey's Manual* was published in 1974. *Bergey's Manual of Systematic Bacteriology* will be published in four subvolumes, of which the first appeared in January 1984 and the others will appear at approximately 1-year intervals. It is therefore necessary to keep the 8th edition until all four subvolumes of the *Manual* are available. New editions of the *Bergey's Manual for Determinative Bacteriology* (formerly the shorter *Bergey's Manual*) will be published covering subvolumes 1 and 2, and 3 and 4, of the new *Manual* and are designed for bench use.

The 8th edition of *Bergey's Manual* is out of date for those taxa in which new species have been described or in which nomenclatural changes have been made. Furthermore, space limitations make it impossible to fully describe many species. The interested party should, therefore, begin a taxonomic search with *Bergey's Manual* and then augment the information obtained there by searching the *International Journal of Systematic Bacteriology*—in which all new species must be described or reference must be made to the journal in which they are described—and by contacting authorities in the specific field. Other journals that publish papers on new species are the *Journal of Clinical Microbiology*, *Current Microbiology*, *Annales de Microbiologie* (Institut Pasteur), and *Systematic and Applied Microbiology*.

In *Bergey's Manual* (2, 8) bacteria are placed in the kingdom *Prokaryotae*. They are subdivided into four divisions: *Gracilicutes* for gram-negative-type cell walls, *Firmacutes* for gram-positive cell walls, *Tenericutes* for organisms lacking a cell wall (mycoplasmas), and *Mendosicutes* for bacteria that have faulty cell walls and presumably lack peptidoglycan. Each division is further subdivided into classes. Within each class are orders, and within the orders are families or (if family names are not available) morphological groups that are further subdivided to genera and species.

From a functional standpoint, the bacteria are divided into a number of "sections" ("parts" in the 8th edition) on the basis of Gram reaction, oxygen requirement, spore formation, and metabolic pattern (gram-positive anaerobes; gram-negative, facultatively anaerobic rods; endospore-forming rods; gliding, nonfruiting bacteria; gram-negative heterotrophs; etc.). Each section (part) is further divided to the species level or, where pertinent, to subspecific categories such as biogroups and serotypes (serovars).

The following sections are included in subvolume 1 of *Bergey's Manual*: spirochetes; gram-negative, aerobic, microaerophilic, motile helical or curved bacteria; gram-negative, nonmotile or rarely motile curved bacteria; gram-negative aerobic rods and cocci; gram-negative facultatively anaerobic rods; gram-negative anaerobic rods; gram-negative anaerobic cocci; dissimilatory sulfate- or sulfur-reducing bacteria; rickettsias and chlamydias; mycoplasmas; and unclassified endosymbionts. Subvolume 2 will contain gram-positive cocci; endospore-forming rods; gram-positive, regular, nonsporing rods; gram-positive, irregular, nonsporing rods; mycobacteria; and nocardiform bacteria. Subvolume 3 will contain gliding, nonfruiting bacteria; anoxygenic photosynthetic bacteria; budding and/or appendaged bacteria; archaeobacteria; sheathed bacteria; gliding, fruiting bacteria; chemolithotrophic bacteria; and cyanobacteria. Subvolume 4 will contain the streptomycetes and their allies. Until subvolumes 2 through 4 are published, the reader must depend on the 8th edition of *Bergey's Manual* and alternative sources for information on the groups that they will address.

A detailed description of the classification of bacteria is, of course, beyond the scope of this chapter, but some comments are in order.

Cowan has referred to "the trinity that is taxonomy": classification, identification, and nomenclature (3). Before discussing reasons for nomenclatural and taxonomic changes and the concept of a bacterial species, it is necessary to establish working definitions for these terms.

"Classification" is simply an orderly arrangement of bacteria into groups. There is nothing inherently scientific about classification. Mandel has said that "like cigars, a good species and a good classification is one which satisfies" (10). Cowan correctly observed that classification is purpose oriented; thus, a successful classification is not necessarily good, and a good classification is not necessarily successful (4). Very often specialty groups classify the same organisms in a different manner or to a different level.

"Identification" is the practical use of a classification to isolate and distinguish desirable organisms from undesirable ones, to verify the authenticity or