Immunology, Infection, and Immunity
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EDITED BY

Gerald B. Pier
Channing Laboratory, Brigham and Women’s Hospital and Harvard Medical School, Boston, Massachusetts

Jeffrey B. Lyczak
Channing Laboratory, Brigham and Women’s Hospital and Harvard Medical School, Boston, Massachusetts

Lee M. Wetzler
Evans Biomedical Research Center and Division of Infectious Diseases, Department of Medicine, Boston University School of Medicine and Boston Medical Center, Boston, Massachusetts

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For all of their wonderful support and help, I dedicate this book to my wife, Susan Bennett; my two children, Danielle and Elizabeth Pier; members of my laboratory research group, both past and present; and my colleagues at the Channing Laboratory who have made the research and teaching effort all worthwhile

Gerald B. Pier

To my wife, Karen Yates, for always offering her support and for sharing in the successes and the trials of research; to my parents, Bernard and Lorraine Lyczak, for encouraging my learning and curiosity; to my teachers and mentors, for showing me the way and for their patience; and lastly to my students, who, by questioning, have taught me so much

Jeffrey B. Lyczak

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Lee M. Wetzler
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Contributors

Judith E. Allen
Institute of Cell, Animal and Population Biology, University of Edinburgh, Edinburgh EH9 3JT, United Kingdom

Edward Barker
Department of Microbiology and Immunology, State University of New York/Syracuse, Syracuse, NY 13210

Steven A. Bogen
Department of Pathology and Laboratory Medicine, Boston University School of Medicine, Boston, MA 02118

Saskia Boisot
School of Medicine, University of California at San Diego, San Diego, Calif.

Lisa H. Butterfield
Departments of Medicine and Surgery, University of Pittsburgh, Pittsburgh, PA 15213

Carolyn L. Cannon
Division of Allergy and Pulmonary Medicine, Washington University School of Medicine, St. Louis, MO 63110

Howard Ceri
Department of Biological Sciences, University of Calgary, Calgary, Alberta T2N 1N4, Canada

Anil Chandraker
Transplant Research Center, Brigham and Women’s Hospital, 75 Francis St., Boston, MA 02115

Ronald B. Corley
Department of Microbiology, Boston University School of Medicine, Boston, MA 02118

William R. Green
Department of Microbiology and Immunology, Dartmouth Medical School, Lebanon, NH 03756

Hilde-Kari Guttormsen
Channing Laboratory, Brigham and Women’s Hospital and Harvard Medical School, 181 Longwood Ave., Boston, MA 02115

Johannes Huebner
Channing Laboratory and Department of Medicine, Brigham and Women’s Hospital and Harvard Medical School, Boston, MA 02115

Elinor M. Levy
Department of Microbiology, Boston University School of Medicine, Boston, MA 02118

Leo X. Liu
Cambria Biosciences LLC, 8A Henshaw St., Woburn, MA 01801

Jeffrey B. Lyczak
Channing Laboratory, Brigham and Women’s Hospital and Harvard Medical School, 181 Longwood Ave., Boston, MA 02115

Jeff M. Milunsky
Clinical Genetics, Center for Human Genetics, and Department of Pediatrics, Boston University School of Medicine, Boston, MA 02118

Chris Mody
Department of Microbiology and Infectious Diseases, University of Calgary, Calgary, Alberta T2N 1N4, Canada

Francis Moore, Jr.
Department of Surgery, Brigham and Women’s Hospital, Boston, MA 02115

Stephen I. Pelton
Department of Pediatrics, Boston University School of Medicine, and Section of Pediatric Infectious Diseases, Boston Medical Center, Boston, MA 02118
Contributors

Gerald B. Pier
Channing Laboratory and Department of Medicine, Brigham and Women’s Hospital and Harvard Medical School, Boston, MA 02115

Michael Preston
Channing Laboratory and Department of Medicine, Brigham and Women’s Hospital, Boston, MA 02115

Mohamed H. Sayegh
Transplant Research Center, Brigham and Women’s Hospital, 75 Francis St., Boston, MA 02115

Stephen P. Schoenberger
Division of Immune Regulation, La Jolla Institute for Allergy and Immunology, 10355 Science Center Dr., San Diego, CA 92121

Michael K. Shaw
Department of Immunology and Microbiology, Wayne State University School of Medicine, Detroit, MI 48201

Scott Simpson
Evans Biomedical Research Center and Division of Infectious Diseases, Department of Medicine, Boston University School of Medicine and Boston Medical Center, 650 Albany St., Boston, MA 02118

Guillermo E. Taccioli
Department of Microbiology, Boston University School of Medicine, Boston, MA 02118

Harley Y. Tse
Department of Immunology and Microbiology, Wayne State University School of Medicine, Detroit, MI 48201

Arthur O. Tzianabos
Channing Laboratory, Brigham and Women’s Hospital and Harvard Medical School, 181 Longwood Ave., Boston, MA 02115

Lee M. Wetzler
Evans Biomedical Research Center and Division of Infectious Diseases, Department of Medicine, Boston University School of Medicine and Boston Medical Center, 650 Albany St., Boston, MA 02118

J. Patrick Whelan
AIDS Research Center, Massachusetts General Hospital, CN4, Building 149, 149 13th St., Charlestown, MA 02129

Karen E. Yates
Department of Orthopedic Surgery, Brigham and Women’s Hospital and Harvard Medical School, 75 Francis St., Boston, MA 02115
Preface

If one looks around the medical scene in North America or Australia, the most important current change he sees is the rapidly diminishing importance of infectious diseases. The fever hospitals are vanishing or being turned to other uses. With full use of the knowledge we already possess, the effective control of every important infectious disease, with the one outstanding exception of poliomyelitis, is possible.

Sir Frank Macfarlane Burnet
Director of the Walter and Eliza Hall Institute of Medical Research
May 1951

Sir Frank Macfarlane Burnet was one of the greatest immunologists of the 20th century. He won the Nobel Prize in physiology and medicine for his discoveries related to the phenomenon of immunological tolerance. His work was carried out at a time when the disciplines of microbiology and immunology were completely entwined, and his prophecy in 1951 came at a time following the emergence in the 1930s and 1940s of effective antibiotics for bacterial infections. These drugs, along with continued use and development of vaccines, caused dramatic changes in medicine, particularly in the field of infectious diseases. Yet, over half a century later, his prophecy has not come to pass, and indeed it is poliovirus, and not other infectious agents, that is mostly controlled and likely will be eliminated as a cause of human disease in the near future.

There are many reasons why microbes have outwitted humans’ ability to control infectious diseases. But at the center of this struggle between microbes and humans is the immune system. Functionally, it exists for one major purpose: to prevent and control infections with pathogenic microbes and eliminate the pathogens and their harmful products from multicellular hosts. Without an immune system, there is only a short period of survival, terminated by overwhelming infection. Without an immune system but with complete environmental elimination of microbes, as occurred with the famous “bubble boy,” David Vetter, a human can grow and survive. Immune function is generally not needed for the successful function of other body organs and physiologic systems. Similarly, many genetically manipulated strains of mice lacking functional immune systems can grow and survive if kept in environments that exclude pathogenic microbes. It is with the acknowledgment of this centrality of function of the immune system that we proudly publish this textbook, Immunology, Infection, and Immunity, bringing the basic molecular and cellular components of the immune system into close juxtaposition to the pathogenesis and prevention of infectious diseases.

This is not to exclude the other important areas where the immune system is of central importance to human health and disease. In addition to the emphasis on infectious diseases, the book focuses strongly on those areas where the immune system does not act when it should (primary and acquired immunodeficiency and the failure to control cancer) as well as areas where the overactivity or dysregulation of the immune system is a cause of pathology (hypersensitivity reactions, including allergy and asthma; autoimmunity; and the unwanted immune responses to transplanted tissues and organs). These topics are all part of the study of the basic biology of the immune system and represent important areas where the centrality of immune system function affects health. But even in these areas, the root cause of the pathology can often be tied to the central function of the immune system in preventing and controlling infections. In immunodeficiency states, the affected individual most often struggles with infections, which are often the cause of death. Individuals with serious diseases due to cancer are dealing with pathologic events with many parallels to those that occur in dealing with an infectious pathogen:
an out-of-control progression of the growth of an undesired living entity. In the case of cancer, a cell derived from one’s own body causes disruption of the normal function of tissues and organs. Disease, and all too often death, is the outcome of the uncontrolled growth of microbial or cancerous cells. Even for the overreactive immune diseases, the basic immunologic process that is used to fight infection—inflammation—goes out of control and harms one’s own tissues. The various manifestations and functions of the cellular and molecular components of the immune system that have evolved to control and prevent infectious diseases are inextricably linked with the pathology of other diseases.

Immunology is admittedly not the easiest subject to teach and learn, but it is one of the most fascinating, challenging, and important areas of biology. A few immunologists can be obtuse and circular. In teaching students basic immunology, we often have had to encourage patience in students when they can encounter definitions such as “An antibody is a substance made by a mammal in response to an encounter with a foreign antigen. A foreign antigen is a substance that induces an antibody response in an animal.” True, accurate, but not highly informative. To bring the full flavor and excitement of immunology to new students, we have assembled an outstanding group of contributors with expertise in the multiple areas of immunology to provide up-to-date information in a field that moves all too rapidly. There are a variety of presentation styles, but all of the chapters have thematic and structural aspects standardized to provide critical information in a comprehensible style. Importantly, this text is intended to complement traditional views and dogmas about immunology with today’s cutting-edge ideas and experimental data describing how the immune system works, some of which are challenging and changing some long-held beliefs about immunology.

While there are other excellent basic textbooks of immunology, most have different organizations and emphases from that in Immunology, Infection, and Immunity. To teach both basic and applied aspects of immunology, we have used, where feasible, examples and illustrations depicting basic immunologic processes in conjunction with their role in infectious or other diseases. The foundation concepts of immunology are among the most exciting in modern biology and medicine, but their application to the real world of diseases and health is a concept never far from the intent of researchers—even those concepts that define the most detailed (some might even say arcane) molecular and cellular functions of the immune system. It is to this goal of scientific inquiry that we have focused the information and content in this book.

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About the Editors

Gerald B. Pier (middle editor in photo) received his bachelor’s degree in liberal arts from the now-defunct Raymond College cluster college at the University of the Pacific in Stockton, Calif., followed by a Ph.D. in microbiology from the University of California at Berkeley. He received a National Research Council postdoctoral fellowship award to work in the Department of Bacterial Diseases at the Walter Reed Army Institute of Medical Research, where he started a research program on pathogenesis and immunity to *Pseudomonas aeruginosa*. He moved to the Channing Laboratory in the Department of Medicine at Brigham and Women’s Hospital and Harvard Medical School and is now a professor of medicine (microbiology and molecular genetics) at Harvard Medical School. His primary research interests encompass pathogenesis and immunity to *P. aeruginosa*, *Staphylococcus aureus*, and *Staphylococcus epidermidis*, with major goals focused on understanding basic and applied aspects of immunity to pathogenic microbes. He started teaching a two-semester immunology course to undergraduate and graduate students in 1980, and compiling and editing *Immunology, Infection, and Immunity* are among the major culminations of this teaching effort.

Jeffrey B. Lyczak (left) received his bachelor of science degree in biology from Saint Joseph’s University in Philadelphia, Pa. He then studied at the Department of Microbiology and Molecular Genetics of the University of California at Los Angeles, where he performed his dissertation research on the function of the antibody immunoglobulin E. He moved to the Channing Laboratory in the Department of Medicine at Brigham and Women’s Hospital and Harvard Medical School to do a postdoctoral fellowship studying corneal infection by *P. aeruginosa*. Upon completion of his fellowship, he remained at the Channing Laboratory as a junior faculty member to expand his research to the field of gastrointestinal infection by *Salmonella enterica*. He also began teaching introductory-level immunology courses offered to graduate and undergraduate students at Harvard University.

Lee M. Wetzler (right) received his bachelor of science degree at the State University of New York at Binghamton and his doctorate in medicine at the State University of New York at Syracuse/Upstate Medical Center. He performed his medical residency at the University of Michigan. Then he became a postdoctoral fellow in the Laboratory of Bacterial Pathogenesis and Immunology at the Rockefeller University, studying the vaccine potential of neisserial outer membrane proteins, and was eventually promoted to assistant professor. He then moved to the Division of Infectious Diseases in the Department of Medicine at the Boston University School of Medicine, where he is now an associate professor in both the Department of Medicine and the Department of Microbiology. He studies innate immunity to bacteria and its relationship to immune protection and vaccine development.
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