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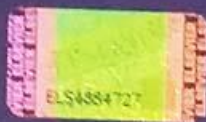
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Basic Immunology

FUNCTIONS AND DISORDERS
OF THE IMMUNE SYSTEM

South East Asia Edition

ABUL K. ABBAS
ANDREW H. LICHTMAN
SHIV PILLAI



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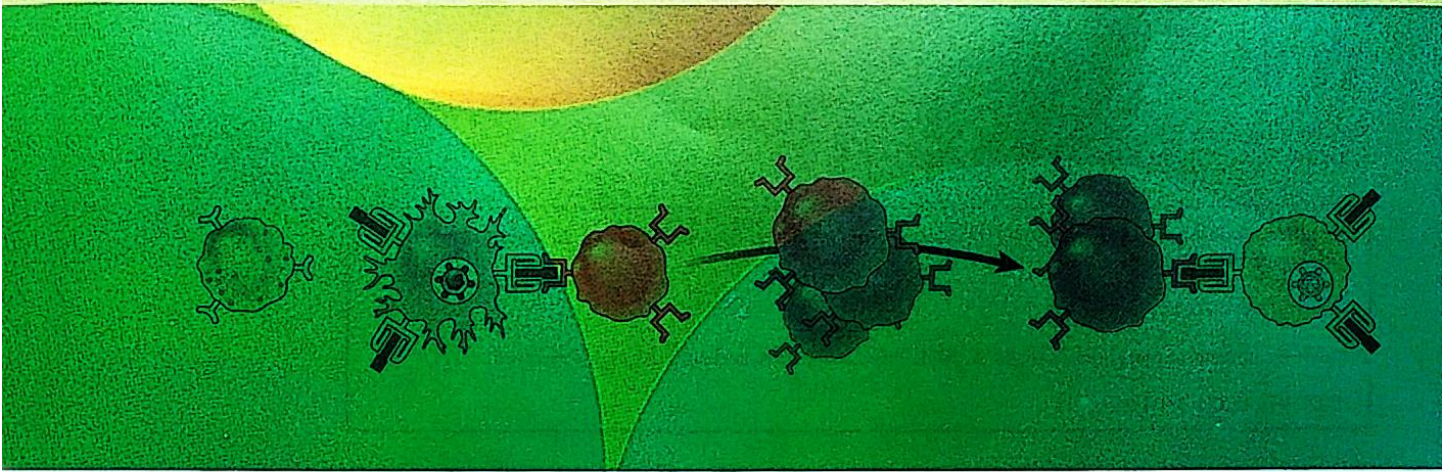
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Basic

IMMUNOLOGY

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SIXTH EDITION



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Basic IMMUNOLOGY

South East Asia Edition

FUNCTIONS AND DISORDERS OF THE IMMUNE SYSTEM

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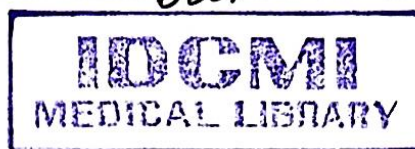
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FOREWORD

There has been spectacular progress in Immunology and the past few decades in particular, has been a tumultuous journey of discovery of the intricacies of the immune system, revolutionising our understanding of the same. A lot of complicated details have emerged about the cells of the immune system, T-cell and B-cell activation and differentiation mechanisms, MHC-restricted peptide recognition, autoimmunity and congenital and acquired immune disorders. Breakthroughs in molecular techniques have created the possibility of being able to strategize and decide on delivery of newer targeted diagnostic and therapeutic interventions. These are yielding insights that have paved the way for a whole new array of therapeutic advances by use of specialized antibodies, recombinant proteins, or gene-modified cells that prevent or end unwanted immune responses to self, or amplify immunity against infections and cancer cells, that the immune system may otherwise be incompetent in tackling.

Immunology has now become a vast subject also covering a wide area of technology. The shortage of reference materials in the area and the need to present the subject in a relatively simplified way defined the need for the present book. The South East Asia edition of *Basic Immunology* has been revised to include all the recent important advances and current accepted concepts of immunology, in sufficient detail, so that they would be understood by students of the discipline, without making the text too extensive and cumbersome. This chapters gives a concise introduction to immunological concepts and then breaks down all immunology into logically arranged, straightforward, manageable, easily understandable and assimilable, building blocks.

The authors have emphasized on the mechanisms of natural defences against infectious agents, mechanisms underlying autoimmune dysfunction, primary immune-deficiencies, autoimmune diseases, cancer immunology (with special focus on clinical aspects), including disease pathogenesis and the development of novel therapies based on the basic science and principles of immunology. They have presented the most important principles governing the function of the immune system by synthesizing key concepts from the vast amount of experimental data that now exists in the field of immunology. They have made liberal use of illustrations to highlight important principles and have included ample clinical information to illustrate how the principles of immunology may be applied to common human diseases. A brief summary and review questions are given at the end of every chapter for easy recapitulation and self assessment. It is quite obvious that the preparation of this material demanded a lot of effort from the authors and I anticipate that it will be very well accepted by its readership in the medical fraternity and acknowledged for the contribution.

The book is aimed at medical undergraduates, post-graduates, researchers, or any scientifically inclined reader interested in immunology.

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PREFACE

The sixth edition of *Basic Immunology* has been revised to include recent important advances in our knowledge of the immune system. The original goals of this book, from the earliest edition, were to present current concepts in immunology cogently and also in sufficient detail that they would be understood by students of the discipline, as well as to emphasize clinical aspects, including disease pathogenesis and the development of novel therapies based on the basic science of immunology. These are the goals that we continue to strive for. With improving understanding of the normal immune response, we believe it is possible to present the fundamental knowledge in a concise way. In addition, there has been exciting progress in applying basic principles to understanding and treating human diseases, a topic that is of paramount interest for students of medicine and allied health sciences. Foremost among these recent advances is the development of cancer immunotherapy, which dramatically illustrates how foundational science can be translated into clinical practice.

More specifically, we have focused on the following objectives. First, we have presented the most important principles governing the function of the immune system by synthesizing key concepts from the vast amount of experimental data that have emerged in the field of immunology. Our judgment of what is most important is based largely on what is most clearly established by scientific investigation and is essential for understanding the major functions of the immune system. We have also prioritized content that is relevant to human health and disease. We have realized that in any concise discussion of complex phenomena, it is inevitable that exceptions and caveats cannot be considered in detail, so these have largely been omitted. Second, we have focused on immune responses against infectious microbes, and most of our discussions of the immune system are in this context. Third, we have made liberal use of illustrations to highlight important principles, but we have reduced factual details that may be found in more comprehensive textbooks. Fourth, we have also discussed

immunologic diseases from the perspective of principles, emphasizing their relation to normal immune responses and avoiding details of clinical syndromes and treatments. We have included selected clinical cases in an appendix to illustrate how the principles of immunology may be applied to common human diseases. Finally, in order to make each chapter readable on its own, we have repeated key ideas in different places in the book. We feel such repetition will help students to grasp the most important concepts.

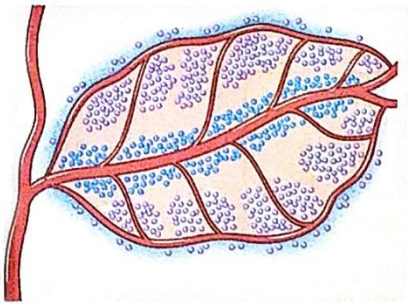
We hope that students will find this new edition of *Basic Immunology* clear, cogent, manageable, and enjoyable to read. We hope the book will convey our sense of excitement about how the field has evolved and how it continues to grow in relevance to human health and disease. Finally, although we were spurred to tackle this project because of our associations with medical school courses, we hope the book will be valued by students of allied health and biology as well. We will have succeeded if the book can answer many of the questions these students have about the immune system and, at the same time, encourage them to delve even more deeply into immunology.

Several individuals played key roles in the writing of this book. Our editor, James Merritt, has been an enthusiastic source of encouragement and advice. Our talented illustrator, David Baker, continues to effectively convert our ideas into pictures that are informative and aesthetically pleasing. Our development editor, Rebecca Grulow, has kept the project organized and on track despite pressures of time and logistics. Clay Broeker has moved the book through the production process in an efficient and professional manner. To all of them we owe our many thanks. Finally, we owe an enormous debt of gratitude to our families, whose support and encouragement have been unwavering.

Abul K. Abbas
Andrew H. Lichtman
Shiv Pillai

CONTENTS

- 1 Introduction to the Immune System, 1**
Nomenclature, General Properties, and Components
 - 2 Innate Immunity, 23**
The Early Defense Against Infections
 - 3 Antigen Capture and Presentation to Lymphocytes, 51**
What Lymphocytes See
 - 4 Antigen Recognition in the Adaptive Immune System, 73**
Structure of Lymphocyte Antigen Receptors and Development of Immune Repertoires
 - 5 T Cell–Mediated Immunity, 96**
Activation of T Lymphocytes
 - 6 Effector Mechanisms of T Cell–Mediated Immunity, 119**
Functions of T Cells in Host Defense
 - 7 Humoral Immune Responses, 137**
Activation of B Lymphocytes and Production of Antibodies
 - 8 Effector Mechanisms of Humoral Immunity, 158**
Elimination of Extracellular Microbes and Toxins
 - 9 Immunologic Tolerance and Autoimmunity, 177**
Self–Nonself Discrimination in the Immune System and Its Failure
 - 10 Immunology of Tumors and Transplantation, 196**
Immune Responses to Cancer Cells and Normal Foreign Cells
 - 11 Hypersensitivity, 218**
Disorders Caused by Immune Responses
 - 12 Congenital and Acquired Immunodeficiencies, 235**
Diseases Caused by Defective Immunity
- Selected Readings, 252
Glossary, 260
Appendix I: Principal Features of Selected CD Molecules, 288
Appendix II: Cytokines, 296
Appendix III: Clinical Cases, 300
Index, 313



Introduction to the Immune System *Nomenclature, General Properties, and Components*

CHAPTER OUTLINE

Innate and Adaptive Immunity, 3

Types of Adaptive Immunity, 4

Properties of Adaptive Immune Responses, 6

Specificity and Diversity, 6

Memory, 7

Other Features of Adaptive Immunity, 8

Cells of the Adaptive Immune System, 9

Lymphocytes, 9

Antigen-Presenting Cells, 14

Tissues of the Immune System, 15

Peripheral (Secondary) Lymphoid Organs and
Tissues, 15

Lymphocyte Recirculation and Migration into
Tissues, 20

Summary, 21

The term “immunity” in a biologic context has historically referred to resistance to pathogens; however, reactions to some noninfectious substances including harmless environmental molecules, tumors, and even unaltered host components are also considered forms of immunity (allergy, tumor immunity, and autoimmunity, respectively). The collection of cells, tissues, and molecules that mediate these reactions is called the **immune system**, and the coordinated response of these cells and molecules to pathogens and other substances comprises an **immune response**.

The most important physiologic function of the immune system is to prevent or eradicate infections (Fig. 1.1), and this is the principal context in which immune responses are discussed throughout this book. In addition, it prevents the growth of some tumors, and some cancers can be treated by stimulating immune responses against tumor cells. The immune system also plays a major role in the repair of damaged tissues. Because the immune system can respond to microbial and nonmicrobial substances and also can cause disease under some circumstances,

a more inclusive definition of the immune response is a reaction to microbes, as well as to other molecules that are recognized as foreign, regardless of the physiologic or pathologic consequence of such a reaction. Immunology is the study of immune responses in this broader sense and of the cellular and molecular events that occur after an organism encounters microbes and other foreign molecules.

The importance of the immune system for health is dramatically illustrated by the frequent observation that individuals with defective immune responses are susceptible to serious, often life-threatening infections. Conversely, stimulating immune responses against microbes through vaccination is the most effective method for protecting individuals against infections; this approach has led to the worldwide eradication of smallpox, the only disease that has been eliminated from civilization by human intervention (Fig. 1.2). The appearance of acquired immunodeficiency syndrome (AIDS) in the 1980s tragically emphasized the importance of the immune system for defending individuals against infection.