

**PBS**  
BOARD REVIEW SERIES

美国医师执照考试精要与习题系列

# 微生物学与免疫学 精要与习题

## Microbiology & Immunology (第6版)

Louise Hawley

Richard J. Ziegler

Benjamin L. Clarke

Outline format highlights the most tested topics for USMLE Step 1

More than 360 board-style questions help test your memorization and mastery



北京大学医学出版社



# Microbiology and Immunology

# 微生物学与免疫学

## 精要与习题

(第6版)

### **Louise Hawley, PhD**

Professor and Chair  
Department of Microbiology and Immunology  
Ross University School of Medicine  
Dominica, West Indies

### **Richard J. Ziegler, PhD**

Professor of Microbiology  
Department of Anatomy, Microbiology, and Pathology  
University of Minnesota Medical School-Duluth  
Duluth, Minnesota

### **Benjamin L. Clarke, PhD**

Associate Professor  
Department of Medical Microbiology and Immunology  
University of Minnesota Medical School-Duluth  
Duluth, Minnesota

北京大学医学出版社  
Peking University Medical Press

## 图书在版编目 (CIP) 数据

微生物学与免疫学精要与习题=Microbiology and immunology:

第6版; 英文/(多) 哈维 (Hawley, L.), (美) 齐格勒 (Ziegler, J. R.),  
(美) 克拉克 (Clarke, L. B.) 编. —北京: 北京大学医学出版社, 2015. 1  
ISBN 978-7-5659-0957-3

I. ①微… II. ①哈… ②齐… ③克… III. ①微生物学-  
医师-资格考试-自学参考资料-英文②免疫学-医师-资格考试-  
自学参考资料-英文 IV. ①R37②R392

中国版本图书馆 CIP 数据核字 (2014) 第 230815 号

北京市版权局著作权合同登记号: 图字 01-2014-4142

Louise Hawley, Richard J. Ziegler, Benjamin L. Clarke. Microbiology and Immunology 6th ed  
ISBN: 978-1-4511-7534-9

Copyright © 2014, 2010, 2002, 1997, 1990 by Lippincott Williams & Wilkins, a Wolters Kluwer business.  
All Rights reserved.

This is a reprint under copublishing agreement with Lippincott Williams & Wilkins/Wolters Kluwer  
Health, Inc., USA

本书限在中华人民共和国境内 (不包括香港、澳门特别行政区及台湾) 销售。

本书封底贴有 Wolters Kluwer Health 激光防伪标签, 无标签者不得销售。

本书提供了药物的准确的适应证、副作用和疗程剂量, 但有可能发生改变。读者须阅读药商提供  
的外包装上的用药信息。作者、编辑、出版者或发行者对因使用本书信息所造成的错误、疏忽或  
任何后果不承担责任, 对出版物的内容不做明示的或隐含的保证。作者、编辑、出版者或发行者  
对由本书引起的任何人身伤害或财产损失不承担任何法律责任。

## 微生物学与免疫学精要与习题 (第6版)

编 写: Louise Hawley, Richard J. Ziegler, Benjamin L. Clarke

出版发行: 北京大学医学出版社

地 址: (100191) 北京市海淀区学院路 38 号 北京大学医学部院内

电 话: 发行部 010-82802230; 图书邮购 010-82802495

网 址: <http://www.pumpress.com.cn>

E-mail: [booksale@bjmu.edu.cn](mailto:booksale@bjmu.edu.cn)

印 刷: 中煤涿州制图印刷厂北京分厂

经 销: 新华书店

责任编辑: 冯智勇 责任印制: 张京生

开 本: 787mm×1092mm 1/16 印张: 22.5 字数: 503 千字

版 次: 2015 年 1 月第 1 版 2015 年 1 月第 1 次印刷

书 号: ISBN 978-7-5659-0957-3

定 价: 93.00 元

版权所有, 违者必究

(凡属质量问题请与本社发行部联系退换)

## 出版说明

BRS (BOARD REVIEW SERIES) 是美国医师执照考试 (USMLE) 的品牌丛书, 该系列书融知识精要、临床关联和 USMLE 题目为一体, 既有利于知识学习, 又有助于通过 USMLE 及医学相关的考试, 被众多通过 USMLE 的考生推荐为必读参考书, 并被世界多所著名医学院校选定为教学用书。

该系列书具有以下特点:

- 提供每门学科最核心的知识, 帮助你掌握学科知识的精华
- 大量的图表, 使知识可视化呈现, 易于理解和记忆
- “临床关联”, 帮助你把基础和临床知识融会贯通
- 每章后附有 USMLE 题目, 并有详细解析, 帮助你通过 USMLE 等各种考试

为了帮助参加 USMLE 的考生得到最新的考试参考书, 并服务于国内医学院校的双语教学和留学生教学, 北京大学医学出版社与 Wolters Kluwer Health 合作, 影印出版了该系列书的最新版本, 包括:

- 生理学 精要与习题 (第 6 版)
- 病理学 精要与习题 (第 5 版)
- 药理学 精要与习题 (第 6 版)
- 大体解剖学 精要与习题 (第 7 版)
- 微生物学与免疫学 精要与习题 (第 6 版)
- 生物化学、分子生物学与遗传学 精要与习题 (第 6 版)

北京大学医学出版社



*The authors dedicate this book to their many students who have been a source of stimulation over the years, and to their many colleagues whose research and insight has resulted in the knowledge described herein.*

*We particularly want to thank Dr. Arthur Johnson, who has retired from both his leadership role as senior author/editor and authorship of the immunology section.*



# Acknowledgements

The authors are grateful for the excellent organizational and secretarial skills of Wendy Schwartz, who aided in the preparation of this edition. And very importantly, we want to thank our spouses and kids for their continued support and patience during the rewriting period.

# How to Use this Book

This concise review of microbiology and immunology and its online resources are designed specifically for medical students to successfully prepare for Step 1 of the United States Medical Licensing Examination (USMLE), as well as other examinations. This newest edition remains a succinct description of the most important microbiological and immunological concepts, as well as a review of critical details needed to understand important human infections and the immune system's function and malfunction.

## ORGANIZATION

### Facilitates Use by Either a Bug Approach or Systems Approach

The book is divided into 12 chapters, starting with basic information and then leading the student quickly to the level of detail and comprehension needed for Step 1. For each major category of microbes (e.g., viruses), there is a fundamental chapter (two for the bacteria) followed by an organ-systems infectious disease approach with critical signs/symptoms, epidemiology, etiology, pathogenesis of infections and immune diseases, and the mechanisms for preventing infection and means of identifying and diagnosing the causative agent. Then an updated Chapter 11 (*Clues for Distinguishing Causative Agents*) presents the diseases a second time, this time utilizing an organ systems-based approach presented by text and great graphic flow-charts starting with symptoms frequently mentioned in case-based questions. Included also are tables listing agents associated with different types of rashes. New to the 6th edition are detailed summary tables of the characteristics and details of the different agents causing meningitis, encephalitis, upper and lower respiratory infections, and pneumonias.

Because many medical schools have switched to a fundamentals block followed by organ system modules, we have created an-online 6th edition *Systems-Based Table of Contents/Guide* which facilitates use in a system-base course by listing both the pages of reading and chapter question-numbers for these courses. This aids faculty using the book in a system-based course and gives the reviewing student options for how they want to organize their review.

The outline format facilitates rapid review of important information. Each chapter is followed by review questions and answers, with explanations that reflect the style and content of the USMLE. These questions are available online as well and can generate systems-based or taxonomic self-quizzes. We have added four separate comprehensive examinations at the end of the book. Each has the same general sub-subject distribution generally found on Step 1 and so may be used as a practice exam and self-assessment tool to help students diagnose their weaknesses prior to, during, and after reviewing microbiology and immunology. The *Comprehensive Exam* questions (accessible online as well) are not mixed with the chapter questions so they can be saved for use after initial study.



Suggestion for increasing your retention: use two cover sheets (one to move down a page and a top one to move left to right) on tables and diagrams to see if you can predict what it is going to say in each section before reading the section.

## KEY FEATURES

- Dual approach (bug and system) in one small book along with new online resources allows flexibility in study and self-testing to improve retention.
- An expanded, resource-rich Chapter 11 which has new System Summary Tables at the end.
- Updated four-color tables and figures summarize essential information for quick recall.
- End-of-chapter review tests feature updated USMLE-style questions.
- Four USMLE comprehensive exams with explanations are included in blocks of similar size to USMLE Step 1.
- Updated and current information is provided in all chapters.

*We wish you well in your study and exams!*

*Louise Hawley, PhD  
Richard J. Ziegler, PhD  
Benjamin L. Clarke, PhD*

# Contents\*

*Dedication*   iii

*Acknowledgements*   iv

*How to Use this Book*   v

---

## **1. GENERAL PROPERTIES OF MICROORGANISMS** **1**

---

- I. The Microbial World   1
- II. Host-Parasite Relationship   3
- III. Sterilization and Disinfection   4
- Review Test   5

---

## **2. BACTERIA** **7**

---

- I. Bacterial Structure   7
- II. Bacterial Growth and Replication   13
- III. Bacterial Viruses   17
- IV. Genetics   22
- V. Bacterial Pathogenesis   30
- VI. Host Defenses to Bacteria   32
- VII. Antimicrobial Chemotherapy   32
- Review Test   37

---

## **3. IMPORTANT BACTERIAL GENERA** **41**

---

- I. Clinical Laboratory Identification   41
- II. Introduction to Major Bacterial Genera   49
- III. Gram-Positive Bacteria   50
- IV. Gram-Negative Bacteria   53
- V. Poorly Gram-Staining Bacteria   56
- Review Test   60

---

## **4. BACTERIAL DISEASES** **65**

---

- I. Major Recurring Species   65
- II. Eye Infections   69

---

\*Systems-based Table of Contents/Guide is available online.

III. Dental Disease	70
IV. Ear and Sinus Infections	71
V. Bacterial Pharyngitis	71
VI. Infections of the Respiratory System	72
VII. Pneumonia/Pneumonitis	74
VIII. Nervous System Infections: Meningitis	80
IX. Nervous System Infections: Nonmeningitis Conditions	83
X. Cardiovascular Infections: Vasculitis	83
XI. Cardiovascular Infections: Endocarditis	83
XII. Cardiovascular: Myocarditis	85
XIII. Gastrointestinal Infections	85
XIV. Urinary Tract Infections	91
XV. Skin, Mucosal, Soft Tissue, and Bone Infections	92
XVI. Sexually Transmitted Infections (STIs)	95
XVII. Pregnancy, Congenital, and Perinatal Infections	98
XVIII. Arthropod-Borne and Zoonotic Diseases	98
XIX. Bacterial Vaccines	102
Review Test	107

## 5. VIRUSES

112

I. Nature of Human Viruses	112
II. Viral Classification	113
III. Viral Replication and Genetics	113
IV. Viral Pathogenesis	115
V. Host Defenses to Viruses	119
VI. Immunotherapy, Antivirals, and Interferon	120
VII. Diagnostic Virology	125
VIII. DNA Viruses	126
IX. RNA Viruses	129
X. Slow Viruses and Prions	138
XI. Oncogenic Viruses	139
Review Test	141

## 6. SYSTEM-BASED AND SITUATIONAL VIRAL INFECTIONS

145

I. Eye Infections	145
II. Ear Infections	146
III. Upper Respiratory Tract (Mouth and Throat) Infections	146
IV. Lower Respiratory Tract Infections	147
V. Gastrointestinal Infections	148
VI. Liver Infection	149
VII. Urinary Tract Infections (UTIs)	151
VIII. Cardiovascular Infections	151
IX. Nervous System Infections	151
X. Skin, Mucosal, and Soft Tissue Infections	153
XI. Childhood Infections	154
XII. Congenital and Neonatal Infections	155

<b>XIII. Sexually Transmitted Diseases</b>	156
<b>XIV. Postinfectious Disease</b>	157
<b>XV. Organ Transplant-Associated Diseases</b>	157
<b>XVI. Arboviral and Zoonotic Diseases</b>	157
<b>Review Test</b>	158

## **7. MYCOLOGY 161**

<b>I. Overview of Fungi</b>	161
<b>II. Fungal Groups</b>	165
<b>III. Overview of Fungal Diseases</b>	165
<b>IV. Diagnosis of Fungal Infections</b>	166
<b>V. Antifungal Drugs</b>	167
<b>Review Test</b>	169

## **8. FUNGAL DISEASES 170**

<b>I. Superficial Skin Infections</b>	170
<b>II. Cutaneous Mycoses</b>	171
<b>III. Mucocutaneous Candidiasis</b>	172
<b>IV. Subcutaneous Mycoses</b>	173
<b>V. Pneumonias/Systemic Mycoses: Pathogens</b>	173
<b>VI. Opportunistic Mycoses</b>	177
<b>VII. Tables for Self-Testing</b>	179
<b>Review Test</b>	181

## **9. PARASITOLOGY 186**

<b>I. Characteristics of Parasites and Their Hosts</b>	186
<b>II. Protozoan Parasites</b>	186
<b>III. Worms</b>	187
<b>Review Test</b>	189

## **10. PARASITIC DISEASES 190**

<b>Review Test</b>	201
--------------------	-----

## **11. CLUES FOR DISTINGUISHING CAUSATIVE INFECTIOUS AGENTS (SYSTEMS APPROACH) 205**

<b>I. Conjunctivitis</b>	205
<b>II. Pneumonias</b>	205
<b>III. Diarrheas and Dysentery</b>	210
<b>IV. Acute Meningitis</b>	211

- V. Bacterial and Viral Skin Infection and Rashes 211
- VI. Genitourinary Tract Infections 213
- VII. System Summaries of Infectious Agents 224
  - A. Characteristics of Important Causes of Encephalitis 224
  - B. Characteristics of Important Causes of Meningitis 225
  - C. Characteristics of Important Causes of Pneumonia 227
  - D. Characteristics of Important Causes of Lower Respiratory Tract Infections 232
  - E. Characteristics of Important Causes of Upper Respiratory Tract Infections 233

Review Test 235

## 12. IMMUNOLOGY

238

- I. Overview 238
- II. Non-Specific Barriers 239
- III. Inflammation and Soluble Factors 240
- IV. Mediators of Inflammation and Immunity 245
- V. Innate Immunity 246
- VI. Antibodies 252
- VII. Properties of Antibodies 254
- VIII. Immunogenetics 258
- IX. Adaptive Immunity 263
- X. Response to Antigen 270
- XI. Immunologic Assays 274
- XII. Clinical Immunological Disorders 277

Review Test 289

**Comprehensive Examination: Block 1 294**

**Comprehensive Examination: Block 2 304**

**Comprehensive Examination: Block 3 314**

**Comprehensive Examination: Block 4 324**

**Index 335**

# General Properties of Microorganisms

## I. THE MICROBIAL WORLD

### A. Microorganisms.

1. Belong to the Protista biologic kingdom.
2. Include some eukaryotes and prokaryotes, viruses, viroids, and prions.
3. Are classified according to their structure, chemical composition, and biosynthetic and genetic organization.

### B. Eukaryotic cells (Table 1.1).

1. Contain organelles and a nucleus bounded by a nuclear membrane.
2. Contain complex phospholipids, sphingolipids, histones, and sterols.
3. Lack a cell wall. (Plant cells and fungi have a cell wall.)
4. Have multiple diploid chromosomes and nucleosomes.
5. Have relatively long-lived mRNA formed from the processing of precursor mRNA, which contains exons and introns.
6. Have 80S ribosomes and uncoupled transcription and translation.
7. Include **protozoa** and **fungi**.
  - a. Organisms in **kingdom Protozoa** are classified into seven phyla; three of these phyla (Sarcodina, Apicomplexa, and Ciliophora) contain medically important species that are human parasites.
  - b. Organisms in **kingdom Fungi**:
    - (1) Are **eukaryotic** cells with a complex carbohydrate cell wall.
    - (2) Have ergosterol as the dominant membrane sterol.
    - (3) May be **monomorphic**, existing only as single-celled **yeasts** or multicellular, filamentous **molds**.
    - (4) May be **dimorphic**, existing as **yeasts or molds depending on temperature and nutrition**.
    - (5) May have both asexual and sexual reproduction capabilities. Deuteromycetes, or Fungi Imperfecti, have no known sexual stages.

### C. Prokaryotic cells (see Table 1.1).

1. Have no organelles, no membrane-enclosed nucleus, and no histones; in rare cases, they contain complex phospholipids, sphingolipids, and sterols.
2. Have 70S ribosomes composed of 30S and 50S subunits.
3. Have a cell wall composed of peptidoglycan-containing muramic acid.
4. Are haploid with a single chromosome.
5. Have short-lived, unprocessed mRNA.
6. Have coupled transcription and translation.

**table 1.1** Components of Microbial Cells

Structure	Composition	Cell Type				
		Fungi	Gram-Positive Bacteria	Gram-Negative Bacteria	Mycoplasmas	Chlamydia* Rickettsia*
Envelope capsule	Polysaccharide or polypeptide	— or +**	+ or —	+ or —	—	—
<b>Wall</b>						
Chitin	Poly- <i>N</i> -acetylglucosamine	+	—	—	—	—
Peptidoglycan	Poly- <i>N</i> -acetylglucosamine- <i>N</i> -acetylmuramic acid tetrapeptide	—	+	+	—	+
Periplasm	Proteins and oligosaccharides	—	—	+	—	+
Lipoprotein	Lipoprotein	—	—	+	—	+
Outer membrane	Proteins, phospholipids, and lipopolysaccharide	—	—	+	—	+
<b>Appendages</b>						
Pili	Protein	—	+ or —	+ or —	—	—
Flagella	Protein	—	+ or —	+ or —	—	—
Cell membrane	Proteins and phospholipids	+ (plus ergosterol)	+	+	+	+
<b>Cytosol</b>						
Organelles	Protein, phospholipids, and nucleic acids	+	—	—	—	—
80S ribosomes	Protein and RNA	+	—	—	—	—
70S ribosomes	Protein and RNA	—	+	+	+	+
<b>Genetic material</b>						
Nucleus	Protein, phospholipids, and nucleic acids	+	—	—	—	—
Nucleoid	Protein and nucleic acids	—	+	+	+	+
Plasmids	DNA	+ or —	+ or —	+ or —	+ or —	+ or —
Transposons	DNA	+	+	+	—	+
<b>Spores</b>						
Reproductive spores	All cellular components	+	—	—	—	—
Endospores	All cellular components plus dipicolinic acid	—	+ or —	—	—	—

\*Obligate intracellular pathogens.

\*\**Cryptococcus neoformans* is the only medically important fungus with a capsule.

7. Include **typical bacteria**, **mycoplasmas**, and **obligate intracellular bacteria**.
  - a. **Typical bacteria:**
    - (1) Have a **cell wall**.
    - (2) May be normal flora or may be pathogenic in humans.
    - (3) Do not have a sexual growth cycle; however, some can produce asexual spores.
  - b. **Mycoplasmas:**
    - (1) Are the smallest and simplest of the bacteria that are self-replicating.
    - (2) Lack a cell wall.
    - (3) Are the only prokaryotes that contain **sterols**.
  - c. **Obligate intracellular bacteria** include **Rickettsia** and **Chlamydia**.
    - (1) **Rickettsia** are incapable of self-replication and depend on the host cell for adenosine triphosphate (ATP) production.
    - (2) **Chlamydia** are bacteria-like pathogens with a complex growth cycle involving intracellular and extracellular forms. They depend on the host cell for ATP production.

#### D. Viruses.

1. Are not cells and are not visible with the light microscope.
2. Are **obligate intracellular parasites**.
3. Contain no organelles or biosynthetic machinery, except for a few enzymes.
4. Contain either RNA or DNA as genetic material.
5. Are called **bacteriophages** (or **phages**) if they have a bacterial host.

#### E. Viroids.

1. Are not cells and are not visible with the light microscope.
2. Are **obligate intracellular parasites**.
3. Are single-stranded, covalently closed, circular RNA molecules that exist as base-paired, rod-like structures.
4. Cause plant diseases but have not been proven to cause human disease, although the RNA of the hepatitis D virus (HDV) is viroid-like.

#### F. Prions.

1. Are infectious particles associated with subacute progressive, degenerative diseases of the central nervous system (e.g., Creutzfeldt-Jakob disease).
2. Copurify with a specific glycoprotein (PrP) that has a molecular weight of 27 to 30 kDa. They are resistant to nucleases but are inactivated with proteases and other agents that inactivate proteins.
3. Are altered conformations of a normal cellular protein that can autocatalytically form more copies of itself.

## II. HOST-PARASITE RELATIONSHIP

- A. **Normal flora** consist mainly of bacteria, but fungi and protozoa may be present in some individuals. They can provide useful nutrients (e.g., vitamin K) and release compounds (e.g., colicins) with antibacterial activity against pathogenic bacteria.
  1. They reside in the skin, mouth, nose, oropharynx, large intestine, urethra, and vagina.
  2. Normal flora may produce disease if they invade normally sterile areas of the body or are not properly controlled by the immune system.
- B. **Microbial pathogenicity** refers to a microbe's ability to cause disease, which depends on genetically determined virulence factors. A microbe's pathogenicity is related to its:
  1. Entry
  2. Colonization
  3. Escape from host defense mechanisms
  4. Multiplication
  5. Damage to host tissues



- C. **Virulence factors** are chromosomal and extrachromosomal (plasmid) gene products that affect aspects related to an organism's:
1. Invasion *properties*
  2. Adherence and colonization
  3. Tissue damage induced by toxins, immune system reactions, and intracellular growth
  4. Eluding host defense mechanisms
  5. Antibiotic resistance

### III. STERILIZATION AND DISINFECTION

#### A. Terminology.

1. **Sterility**—total absence of viable microorganisms as assessed by no growth on any medium.
2. **Bactericidal**—kills bacteria.
3. **Bacteriostatic**—inhibits growth of bacteria.
4. **Sterilization**—removal or killing of all microorganisms.
5. **Disinfection**—removal or killing of disease-causing microorganisms.
6. **Sepsis**—infection.
7. **Aseptic**—without infection.
8. **Antisepsis**—any procedure that inhibits the growth and multiplication of microorganisms.

#### B. Kinetics of killing.

1. Killing is affected by the medium, the concentration of organisms and antimicrobial agents, temperature, pH, and the presence of endospores.
2. It can be exponential (logarithmic); can result in a killing curve that becomes asymptotic, requiring extra considerations in killing final numbers, especially if the population is heterogeneous relative to sensitivity.

#### C. Methods of control.

1. **Moist heat** (autoclaving at 121°C/250°F for 15 minutes at a steam pressure of 15 pounds per square inch) kills microorganisms, including endospores.
2. **Dry heat** and **incineration** are both methods that oxidize proteins, killing bacteria.
3. **Ultraviolet radiation** blocks DNA replication.
4. **Chemicals:**
  - a. **Phenol** is used as a disinfectant standard that is expressed as a phenol coefficient, which compares the rate of the minimal sterilizing concentration of phenol to that of the test compound for a particular organism.
  - b. **Chlorhexidine** is a diphenyl cationic analog that is a useful topical disinfectant.
  - c. **Iodine** is bactericidal in a 2% solution of aqueous alcohol containing potassium iodide. It acts as an oxidizing agent and combines irreversibly with proteins. It can cause hypersensitivity reactions.
  - d. **Chlorine** inactivates bacteria and most viruses by oxidizing free sulfhydryl groups.
  - e. **Quaternary ammonium compounds** (e.g., **benzalkonium chloride**) inactivate bacteria by their hydrophobic and lipophilic groups, interacting with the cell membrane to alter metabolic properties and permeability.
  - f. **Ethylene oxide** is an alkylating agent that is especially useful for sterilizing heat-sensitive hospital instruments. It requires exposure times of 4 to 6 hours, followed by aeration to remove absorbed gas.
  - g. **Alcohol** requires concentrations of 70% to 95% to kill bacteria given sufficient time. Isopropyl alcohol (90% to 95%) is the major form in use in hospitals.