BRS 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

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精要与习题
（第 6 版）

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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。

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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 Klumer Health 合作，影印出版了该系列书的最新版本，包括：

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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.

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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*

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

chapter 1

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 (Sarcomastigophora, 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 −	−	−	−
Wall							
Chitin	Poly-*N*-acetylglucosamine	+	−	−	−	−	−
Peptidoglycan	Poly-*N*-acetylglucosamine-*N*-acetylmuramic acid tetrapeptide	−	+	+	−	−	+
Periplasm	Proteins and oligosaccharides	−	−	+	−	+	+
Lipoprotein	Lipoprotein	−	−	+	−	+	+
Outer membrane	Proteins, phospholipids, and lipopolysaccharide	−	−	+	−	+	+
Appendages							
Pili	Protein	−	+ or −	+ or −	−	−	−
Flagella	Protein	−	+ or −	+ or −	−	−	−
Cell membrane	Proteins and phospholipids	+ (plus ergosterol)	+	+	+	+	+
Cytosol							
Organelles	Protein, phospholipids, and nucleic acids	+	−	−	−	−	−
80S ribosomes	Protein and RNA	+	−	−	−	−	−
70S ribosomes	Protein and RNA	−	+	+	+	+	+
Genetic material							
Nucleus	Protein, phospholipids, and nucleic acids	+	−	−	−	−	−
Nucleoid	Protein and nucleic acids	−	+	+	+	+	+
Plasmids	DNA	+ or −	+ or −	+ or −	+ or −	+ or −	+ or −
Transposons	DNA	+	+	+	−	+	+
Spores							
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.

Review Test

Directions: *Each of the numbered items or incomplete statements in this section is followed by answers or completions of the statement. Select the ONE lettered answer that is BEST in each case.*

1. A pharmaceutical company has developed a new compound that is well tolerated by the body and inhibits the sterol ergosterol synthesis. Screening of anti-infectious agent activity should be directed toward

(A) Bacteria
(B) Chlamydia species
(C) Fungi
(D) Rickettsia species
(E) Viruses

2. 50S ribosomal subunits are found in

(A) Bacteria
(B) Fungi
(C) Prions
(D) Protozoa
(E) Viruses

3. The normal flora of the large intestine consists mainly of

(A) Bacteria
(B) Fungi
(C) Protozoa
(D) Viruses
(E) No microbial agents

4. The minimal concentration of alcohol necessary to kill bacteria and enveloped viruses is

(A) 30%
(B) 40%
(C) 50%
(D) 60%
(E) 70%

5. Human obligate intracellular pathogens that depend on the host cell for ATP production are

(A) Bacteriophages
(B) Mycoplasma species
(C) Prions
(D) Rickettsia species
(E) Viroids

6. Dimorphism is a characteristic of

(A) Bacteria
(B) Fungi
(C) Prions
(D) Rickettsia species
(E) Viruses

7. A new infectious agent has been isolated from deer ticks. It lacks a cell wall but has 70S ribosomes. This agent is most likely a

(A) Bacterium
(B) Chlamydia species
(C) Mycoplasma species
(D) Rickettsia species
(E) Virus

8. The infectious agent associated with Creutzfeldt-Jakob disease is extremely hardy, but can be inactivated by

(A) Catalases
(B) Hyaluronidases
(C) Nucleases
(D) Phospholipases
(E) Proteases

9. Quaternary ammonium compounds inactivate bacteria because they

(A) Alter metabolic properties of membranes
(B) Bind irreversibly to DNA
(C) Denature proteins
(D) Inactivate 50S ribosomes
(E) Oxidize free sulfhydryl groups