

Preface

Do We Need to Know...?

As you embark upon your studies of the microbial world—and a fascinating world it will be—you will wonder how important some topics are that will be covered. You may ask yourself—or your instructor—how important is this topic to my career? If it is nursing, obviously the material on infectious diseases, epidemiology (the scientific and medical study of the causes, transmission, and control of a disease within a population), and immunology (the study of how our bodies fight an infection or disease) are critical. If you are planning on pharmacy school, add antimicrobial drugs to that list.

But what about some of the other “science” topics, like microbial metabolism and genetics? Are these important to a successful career? A few years ago, the forum section on a Web site called *allnurses.com* (“A Nursing Community for Nurses”) asked nurses “What [microbiology] topics keep resurfacing in your nursing classes?” Among the top responses were some obvious ones, such as antibiotics and antibiotic resistance, infectious diseases, and immunity. But also on that list was microbial genetics.

Perhaps more revealing were the responses to a second question: “What do you wish that you had learned better in microbiology that you thought you would never see again [in your nursing classes]?” Among the answers submitted was metabolism.

Another survey published in *Focus on Microbiology Education* in 2006 (Volume 12 No. 2, p. 7–9) asked nurse educators what they thought were important topics for their students to learn in a microbiology class. The top six in importance were:

1. Bacterial structures and their functions;
2. Viral structures and their functions;
3. Epidemiology and public health issues;

4. Antibiotics;
5. Immunology;
6. Disinfection and antisepsis.

Rounding out the top 10 were:

7. Bacterial metabolism;
8. Fungal structures and their functions;
9. Microbial genetics;
10. Biotechnology (production of vaccines, medicines, and diagnostic techniques).

Notice that in both surveys, the topics of microbial metabolism and microbial genetics are among the top 10 concepts to master and understand. So, make sure you pay attention to what your instructor has to say and what “we need to know” (understand) about these topics. They are important—and they will show up again in your nursing courses!

Besides metabolism and genetics, there is a substantial amount of other information you will need to learn and understand. To facilitate this understanding and coordinate it with class material, I developed a “learning design” format for the textbook (described below) to make reading easier, studying more efficient, and learning uncomplicated. Most importantly, the design allows you to better evaluate your learning and provides you with the tools needed to probe your understanding—that is, chapter learning aids and assessment drills to evaluate your progress. Realize, a prepared student knows her or his mastery before an exam—not as a result of the exam! The “learning design” format facilitates this need.

I am excited that you are using and reading this new, ninth edition of *Alcamo's Fundamentals of Microbiology*. I hope it is very useful in your studies and also enjoyable to read. Always take time to read many of the sidebars (MicroFocus boxes) whether they are assigned or not. They will help in your overall microbiology experience and the realization that microorganisms do rule the world!

Audience

Alcamo's Fundamentals of Microbiology, Ninth Edition, is written for introductory microbiology courses having an emphasis on the biology of human disease. It is geared toward students in health and allied health science curricula such as nursing, dental hygiene, medical assistance, sanitary science, and medical laboratory technology. It also will be an asset to students studying pharmacy, food science, agriculture, environmental science, and health administration. In addition, the text provides a firm foundation for advanced programs in biological sciences, as well as medicine, dentistry, and other health professions.

Organization

Alcamo's Fundamentals of Microbiology, Ninth Edition, is divided into six major areas of concentration. These areas use basic principles as frameworks to provide the unity and diversity of microbiology. Among the principles explored are the variations in structure and growth of microorganisms, the basis for infectious disease and resistance, and the beneficial effects microorganisms have on our lives.

Part 1 deals with the foundations of microbiology. It includes chapters on the origins of microbiology and the universal concepts of growth and metabolism that underpin the science. Part 2 then covers important material on the genetics of microorganisms, including genetic engineering and biotechnology. The discussions carry over to Part 3, where the spectrum of bacterial diseases is surveyed. Part 4 looks at the significance of other microorganisms, including viruses, fungi, and the protozoal and multicellular parasites.

In Part 5 of the text, the emphasis turns to infectious disease and the body's resistance through the immune system. Here, we study the reasons for disease and the means for surviving it. Antibiotics and antibiotic resistance are also covered. Part 6 closes the text with brief discussions of how public health measures interrupt epidemics. Some key insights also are given on the positive effects microorganisms exert through biotechnology.

What's New and Important

Besides the continued emphasis on a global perspective on infection, this edition provides detailed updates to microbial structure and function, disease information and statistics, and the immune system.

Chapter Organization

The chapter sequence and number remain the same as in the previous edition, with one exception: the material on physical and chemical control methods has been moved up to Chapter 7, supplying many applications to the more detailed material in the previous chapters.

The "Learning Design" Concept

The text format includes activities designed to encourage student interaction and assessment. These design elements form an integrated study and learning package (learning tools) for student understanding and assessment.

- **Chapter Introductions** provide a stimulating thought or historical perspective to set the tone for the chapter.
- **Key Concepts** present statements identifying the important concepts in the upcoming section and alert you to the significance of the written material.
- **Boldface Terms** highlight important terms and ideas in the text.
- **Marginal Definitions** present succinct definitions of notable terms as they enter the discussion.
- **Marginal Drawings** provide visual images of bacterial shapes and cell arrangements and eukaryotic cells.
- **Marginal Chemical Structures** present structural formulas for many of the antimicrobial drugs described in Chapter 24.
- **Concept and Reasoning Checks** allow you to pause and either summarize the information presented in the previous section or critically reason through a question pertaining to the previous section.
- **MicroFocus Boxes** explore interesting topics concerning microbiology or microorganisms.
- **MicroInquiry Boxes** allow you to investigate (usually interactively) some important aspect of the chapter being studied.

Rems (Roentgen Equivalent Man):
A measure of radiation dose
related to biological effect.

Marginal Definition

- **Textbook Cases** are embedded in many chapters to help you understand pathogens by presenting contemporary disease outbreaks originally reported by the Centers for Disease Control and Prevention.
- **Figure Questions** further reinforce your understanding of microbiology concepts described in the text.
- **Summary Tables** pull together the similarities and differences of topics discussed in the chapter.
- **Pronouncing Microorganism Names** (inside front and back covers) helps you correctly pronounce those sometimes tongue-twisting microorganism names.
- **Summaries of Key Concepts** condense the major ideas discussed in the chapter. The “learning design” package also includes many useful and important end-of-chapter student assessments.
- **Learning Objectives** outline the important concepts in the chapters through Bloom’s Taxonomy, a classification of levels of intellectual skills important in learning.
- **Self-Test questions** (Step A) are multiple-choice questions focusing on concrete “facts” learned in the chapter. Let’s face it: there is information that needs to be memorized in order to reason critically.
- **Chapter Review** (Step B) contains questions of a somewhat unconventional type to assist review of the chapter contents.
- **Questions for Thought and Discussion** (Step C) encourage students to use the text to resolve thought-provoking problems with contemporary relevance.
- **Applications** (Step D) are questions requiring students to reason critically through a problem of practical significance.

Being Skeptical

One of the seven types of essay boxes new to this edition is titled “Being Skeptical.” A good scientist is a skeptic and skepticism is an important part of science. Skepticism, unlike cynicism, is not unwilling to accept a claim or observation. Skepticism simply says “Prove it!” Science applies scientific reasoning as the method for proof. Thus, a scientist, such as a microbiologist,

MICROFOCUS 5.3: Being Skeptical Germination of 25 Million-Year-Old Endospores?

Endospores have been recovered and germinated from various archaeological sites and environments. Living spores have been recovered and germinated from the intestines of Egyptian mummies several thousand years old. In 1983, archaeologists found viable spores in sediment lining Minnesota’s Elk Lake. The sediment was over 7,500 years old.

All these reports though pale in comparison to the controversial discovery reported in 1995 by researcher Raul Cano of California Polytechnic State University, San Luis Obispo. Cano found bacterial spores in the stomach of a fossilized bee trapped in amber—a hardened resin—produced from a tree in the Dominican Republic. The fossilized bee was about 25 million-years-old. When the amber was cracked open and the material from the abdomen of the bee extracted and placed in nutrient medium, the equally ancient spores germinated. With microscopy, the cells from a colony were very similar to *Bacillus sphaericus*, which is found today in bees in the Dominican Republic. Is it possible for an endospore to survive for 25 million years—even if it is encased in amber?

Critics were quick to claim the bacterial species may represent a modern-day species that contaminated the amber sample being examined. However, Professor Cano had carried out appropriate and rigorous decontamination procedures and sterilized the amber sample before cracking it open. He also carried out all the procedures in a class II laminar flow hood, which prevents outside contamination from entering the working area. In addition, the hood had never been used for any other bacterial extraction processes. Several other precautions were added to eliminate any chance that the spores were modern-day contaminants from an outside source. Still, many scientists question whether all contamination sources had been identified.

The major question that remains is whether DNA can remain intact and functional after so long a period of dormancy. Does it really have a capability of replication and producing new vegetative growth? Granted, the DNA presumably was protected in a resistant spore, but could DNA remain intact for 25 million years?

Research on bacterial DNA suggests the maximum survival time is about 400,000 to 1.5 million years. If true, then the 25 million-year-old spores could not be viable. But that is based on current predictions and they may be subject to change as more research is carried out with ancient DNA.

The verdict? It seems unlikely that such ancient endospores could germinate after 25 million years. Perhaps new evidence will change that perception.

MicroFocus Box

must see the evidence and it must be compelling before the observation or statement is provisionally accepted. The claim is still open to further examination and experimentation.

The “Being Skeptical” essays scattered through the textbook present an often-fantastic statement or claim. The essay then examines the claim using reasoning skills and the scientific process, which is sometimes called the scientific method.

Why Pathogens?

Microorganisms perform many useful services for humans when they produce food products, manufacture organic materials in industrial plants, and recycle such elements as carbon and nitrogen. The emphasis of this book, however, is on the tiny, but significant percentage of microorganisms causing human disease, the so-called pathogens. Why do we emphasize pathogens? Here are several reasons:

- Pathogens have regularly altered the course of human history.
- Pathogens are familiar to audiences of microbiology.
- Pathogens add drama to an invisible world of microorganisms.

- Pathogens illustrate ecological relationships between humans and microorganisms.
- Pathogens point up the diversity of microorganisms.

Moreover, the study of pathogens makes basic science relevant and shows how microbiology interfaces with other disciplines such as sociology, economics, history, politics, and geography. Finally, the study of pathogens helps us to understand contemporary newspaper articles, magazine headlines, and stories on the news. And in the end, that makes us better citizens. Indeed, the famous essayist Thomas Mann once wrote, "All interest in disease is only another expression of interest in life."

Additional Resources

Jones and Bartlett offers an array of ancillaries to assist instructors and students in teaching and mastering the concepts in this text. Additional information and review copies of any of the following items are available through your Jones and Bartlett sales representative or by going to www.jbpub.com/biology.

For the Student

Part 6 of this book, "Environmental and Applied Microbiology," is available online with the access code bound into every new copy of this text (in North America). Additional access codes are available for purchase separately.

The Web site we developed exclusively for the ninth edition of this text, <http://microbiology.jbpub.com/9e>, offers a variety of resources to enhance understanding of microbiology. The site contains eLearning, a free on-line study guide with chapter outlines, chapter essay questions, key term reviews, and short study quizzes.

The *Study Guide* to accompany this textbook contains important information to help you study, take effective class notes, prepare properly for exams, and even to manage your time effectively. The latter is the single most common reason for poor performance in college courses. The *Study Guide* also contains over 3,000 practice exercises and study questions of various types to help you learn and retain the information in the text.

Laboratory Fundamentals of Microbiology, Ninth Edition, is a series of over 30 multipart laboratory exercises providing basic training in

the handling of microorganisms and reinforcing ideas and concepts described in the textbook.

Guide to Infectious Diseases by Body Systems is an excellent tool for learning about microbial diseases. Each of the fifteen body systems units presents a brief introduction to the anatomical system and the bacterial, viral, fungal, or parasitic organism infecting the system.

An anthology called *Encounters in Microbiology (Volume I, Second Edition, and Volume II)* brings together "Vital Signs" articles from *Discover* magazine in which health professionals use their knowledge of microbiology in their medical cases.

For the Instructor

Compatible with Windows® and Macintosh® platforms, the Instructor's Media CD-ROM provides instructors with the following traditional ancillaries:

- The *PowerPoint® Image Bank* provides the illustrations, photographs, and tables (to which Jones and Bartlett Publishers holds the copyright or has permission to reproduce digitally) inserted into PowerPoint slides. You can quickly and easily copy individual images or tables into your existing lecture slides.
- The *PowerPoint Lecture Outline Slides* presentation package, prepared by Jean Revie of South Mountain Community College, provides lecture notes and images for each chapter of *Alcamo's Fundamentals of Microbiology*. Instructors with the Microsoft PowerPoint software can customize the outlines, art, and order of presentation.

The following materials are also available online, at <http://www.jbpub.com/catalog/9780763762582>.

- The *Instructor's Manual*, provided as a text file, includes chapter summaries and complete chapter lecture outlines and answers to all the end-of-chapter assessments.
- *Chapter Assessments Answers* provide short answers to figure questions, Concept and Reasoning Checks, and all end-of-chapter materials.
- The *Test Bank* is available as straight text files. It has been updated by Cindy Ault of Jamestown College, Jackie Reynolds of Richland College, and Sue Katz of Rogers State University.