Preface

The Importance of a Biology (Microbiology) Education

Introductory college courses in the biological sciences (and most other sciences, too) are often seen as courses where students *are told about science* and then *asked to remember "the facts."* Today's world of instant news facts and Internet access provides a mass of readily accessible information about science, some good and some so bad it is counter to logic and evidence. To interpret and use this information correctly and intelligently, you, the student, must know more than a pile of memorized facts. Bruce Alberts, the past president of the U.S. National Academy of Sciences and an acknowledged expert in science education policy, the American Association for the Advancement of Science and the National Science Foundation report *Vision and Change in Undergraduate Biology Education: A Call to Action*, the American Society for Microbiology's *Curriculum Guidelines for Undergraduate Microbiology*, and many other organizations have identified four goals for any biology and microbiology course. The overarching aim of these goals is to prepare students to:

- Know, use, and interpret scientific explanations of the natural world.
- Produce and evaluate scientific evidence.
- Understand the nature and development of scientific knowledge.
- Participate productively in scientific practices and discourse.

These goals require the development of proper critical thinking skills; that is, actively and skillfully applying, analyzing, evaluating, and/or synthesizing information clearly and rationally. A student with critical thinking skills is capable then of achieving the four goals listed above. Importantly, the mastery of such skills is essential in today's job market and that certainly includes the fields of nursing and allied health, pharmacy, medicine, and other health-related fields, all related in part to microbiology.

Because there is a substantial amount of information you will need to learn and understand in microbiology, attaining these skills requires a multifaceted approach. First and foremost, your microbiology instructor is the one who can guide you with "knowing the specifics" and mentor you as you develop these critical thinking skills. In addition, a microbiology textbook should not only support and expand your new knowledge about the microbial world, but also provide examples, evaluations, and assessments to gauge your progress. To facilitate this understanding and coordinate it with class material, this textbook contains a "critical learning design" format (described below) to make reading easier, studying more efficient, and active learning straightforward. 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. The "learning design" format accelerates your success in microbiology—and your career.

I am excited that you are using and reading this new, tenth edition of *Fundamentals of Microbiology*. I hope the textbook 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

Fundamentals of Microbiology, Tenth Edition is written for introductory microbiology courses having an emphasis in the health sciences. 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 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, pharmacy, dentistry, and other health professions.

ORGANIZATION

Fundamentals of Microbiology, Tenth Edition is divided into several areas of concentration. These areas reflect the *Curriculum Guidelines for Undergraduate Microbiology* as recommended by the American Society for Microbiology and provide a framework for the unity and diversity of microbiology. Therefore, among the overarching principles explored (evolution is woven throughout the textbook) are:

Cell Structure and Function

- The evolutionary relatedness of organisms is best reflected in phylogenetic trees.
- While microscopic eukaryotes (fungi and protists) carry out many of the same basic processes as prokaryotes, there are fundamental structural differences within and between them.
- Prokaryotes have specialized structures that often confer critical capabilities and can be targets for antibiotics and immune system defenses.

Metabolic Pathways

- The interactions of microorganisms among themselves and with their environment are determined by their metabolic abilities and diversity.
- Cells, organelles (e.g., mitochondria and chloroplasts), and all major metabolic pathways evolved from early prokaryotic cells.
- The growth of microorganisms can be controlled by physical and chemical means.

Information Flow and Genetics

- Genetic variation can impact microbial functions and the regulation of gene expression is influenced by external and internal molecular cues and/or signals.
- Mutations and horizontal gene transfer, with the immense variety of microenvironments, have provided the means through evolution for an amazing diversity of microorganisms.
- Microbial genomes can be manipulated to alter cell function such that humans can use and harness microorganisms and their products.

Microbial Systems

- The synthesis of viral genetic material and proteins is dependent on interactions with host cells.
- Microorganisms and viruses interact with both human and nonhuman hosts in beneficial, neutral, and detrimental ways, the latter often responsible for infection and disease.
- The replication cycles of viruses differ among virus families and are determined by their unique structures and genomes.

Impact of Microorganisms

- Microbes are essential for life as we know it and the processes that support life.
- Microorganisms provide essential models that give us fundamental knowledge about life processes.
- Human impact on the environment influences the evolution of microorganisms as seen through emerging diseases and the selection of antibiotic resistance.

WHAT'S NEW AND IMPORTANT

When you read this text, you get a global perspective on microbiology and infectious disease that is found in no other similar textbook. Therefore, this edition provides detailed updates to microbial structure and function, microbial genomics, and, of course, disease information and statistics. In addition, this new edition has expanded coverage of:

- **The human microbiome**, the vast assemblage of microbes that we all possess on us and in us. This truly fascinating topic and research area will, in the near future, dramatically change the way we treat physiological and metabolic disorders in the human body and how we can improve our general health and wellbeing.
- **Infectious diseases** that continue to plague many parts of the human population. This includes AIDS, influenza, tuberculosis, and

malaria, sometimes referred to as "the big four" when considering the global mortality numbers.

- **Evolution**, which is rooted into much of the material in many of the chapters.

The "Learning Design" Concept mentioned above has been expanded to provide more tools for developing critical thinking skills. The new features include:

- **Chapter Challenge.** Each activity is designed to test some part of the four goals listed above for science understanding. The challenges help you to think deeper about the chapter material and provide you with the critical thinking skills needed for your future career in nursing or the health sciences. Each challenge includes a critical-thinking question related to the chapter material.
- **Investigating the Microbial World.** Although most of you are not going to become practicing microbiologists, the ability to use, interpret, and evaluate scientific explanations and evidence of the natural world will be important in your careers. Therefore, almost every chapter relates an actual experiment (on an interesting topic) that requires you to apply the process of science and use quantitative reasoning.
- **Figure Art.** Many figures with multipart microbiological processes or figures of organism life cycles have been redesigned in a more readily understandable and visual from.

This new tenth edition of *Fundamentals of Microbiology* retains all of the reading and learning 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.

BEING SKEPTICAL

One of the types of essay boxes in this book is titled **Being Skeptical**. A good scientist is a skeptic and skepticism is an important part of science. Skepticism, unlike cynicism, is not unwillingness 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, 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.

NAVIGATE FUNDAMENTALS OF MICROBIOLOGY

Navigate Fundamentals of Microbiology transforms how students learn and instructors teach by bringing together authoritative and interactive content aligned to course objectives, with student practice activities and assessments, adaptive study planning and remediation, and learning analytics reporting tools. **Navigate Fundamentals of Microbiology** empowers faculty and students with easy-to-use web-based curriculum solutions that optimize student success, identify retention risks, and improve completion rates. Using best practices in instructional design, **Navigate Fundamentals of Microbiology** uniquely focuses on developing students' cognitive intelligence and practical skills needed for success in the 21st century workforce.

Navigate Fundamentals of Microbiology also includes an interactive eBook, interactive course lessons, practice activities, and robust course management tools. It is a fully hosted and supported online learning solution delivered in the Moodle® Course Delivery System. **Navigate Fundamentals of Microbiology** component modules can also be configured for locally hosted learning management systems such as Blackboard, Desire2Learn, and others. Please contact your Jones & Bartlett sales representative for more information.

ADDITIONAL RESOURCES

Jones & Bartlett Learning also offers an array of traditional 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 & Bartlett sales representative or by going to http://www.jblearning.com/science/.

For the Student

The website we developed exclusively for the tenth edition of this text, http://microbiology

.jbpub.com/10e, offers a variety of resources to enhance understanding of microbiology. The site contains chapter summaries, an interactive glossary for key term review, interactive flashcards, crossword puzzles, short study quizzes, and more. Part 6 of this book, "Environmental and Applied Microbiology," is also available for download through the student companion site. Access to this site is free with every new print copy of the text, and is also available for purchase separately.

The *Student 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 *Student 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.

Alcamo's 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 provides instructors with the following traditional ancillaries:

- The *PowerPoint® Image Bank* provides the illustrations, photographs, and tables (to which Jones & Bartlett Learning 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 presentations.
- The *PowerPoint Lecture Outline* presentation package provides lecture notes and images for each chapter of *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.jblearning.com/catalog/9781449688615/.

- 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.
- The *Test Bank* is available as straight text files.