

Preface

Because learning evolves, so do we. Streamlined, completely up to date, and written with deference to the history of microbiology and excitement for the future, the Fourteenth Edition of *Brock Biology of Microorganisms* is the strongest yet. For three generations, students and instructors have relied on the accuracy, authority, consistency, and up-to-date science of *Brock Biology of Microorganisms* to learn the core principles of microbiology and pique their interest in the future of the discipline. With the Fourteenth Edition, students will benefit from the book's emphasis on cutting-edge research, its seamless integration of and introduction to modern molecular microbiology, and a visually stunning art program revision. Additionally, for the first time, *Brock Biology of Microorganisms* is supported by MasteringMicrobiology, Pearson's online homework, tutorial, and assessment system.

Experienced authors Madigan, Martinko, and Stahl welcome two new coauthors on the Fourteenth Edition: Kelly S. Bender and Daniel H. Buckley. Significantly revising the coverage of molecular biology and microbial genetics, Kelly has been highly praised for both her undergraduate teaching and graduate student mentoring at Southern Illinois University. At Cornell, Dan participates in the Cornell Institute for Biology Teachers' summer workshop for high school science teachers and codirects the world-famous Summer Course in Microbial Diversity at Woods Hole. Both new coauthors have greatly strengthened the core mission of *Brock Biology of Microorganisms*: to remain the best learning resource for today's microbiology students and instructors.

What's New in the 14th Edition?

Reorganized and reimagined, the Fourteenth Edition guides students through the six major themes of microbiology in the 21st century as outlined by the American Society of Microbiology Conference on Undergraduate Education (ASMCUE): Evolution, Cell Structure and Function, Metabolic Pathways, Information Flow and Genetics, Microbial Systems, and the Impact of Microorganisms. With enhanced and revised artwork and nearly 200 new color photos, *Brock Biology of Microorganisms* beautifully presents microbiology as the visual science it is. The new chapter-opening features, titled "MicrobiologyNow," engage students in cutting-edge research relevant to each chapter's content and connect to assignable and assessable MasteringMicrobiology coaching activities. "Explore the Microbial World" features focus on specific topics that help students get a feel for the "big picture" in microbiology while simultaneously fueling their scientific curiosity.

Genomics, and all of the various "omics" it has spawned, support content in every chapter of *Brock Biology of Microorganisms*,

reflecting how the omics revolution has transformed all of biology. Gone is the day of microbiology as a descriptive science. Mastering the principles of the dynamic field of microbiology today requires understanding the underlying molecular biology. As authors, we are well aware of this, and have written *Brock Biology of Microorganisms* in a way that provides both the foundation for the science and the science itself. The result is a truly robust and eminently modern treatment of microbiology.

To strengthen the learning experience, additional MasteringMicrobiology content includes chapter-specific reading quizzes, MicroLab Tutorials, MicrobiologyNow coaching activities, Clinical Case and MicroCareer coaching activities, animation quizzes, MCAT Prep questions, and many additional study and assessment tools. Collectively, the content and presentation of *Brock Biology of Microorganisms*, coupled with the powerful learning tools of MasteringMicrobiology, create an unparalleled educational experience in microbiology.

Revision Highlights

Chapter 1

- Chapter 1 has been revised to provide an up-to-date and succinct introduction to and overview of microbiology, including basic elements of cell structure and the phylogenetic tree of life.
- The power of genomics for solving mysteries in microbiology is revealed in a new Explore the Microbial World feature, "The Black Death Decoded" on forensic studies of victims of Europe's "Black Death" outbreak over 650 years ago.

Chapter 2

- Coverage of microbial cell structure and function now combines material on *Bacteria* and *Archaea* with that of microbial eukaryotes, giving students a thorough introduction to comparative cell structure and providing the instructor with all of the tools necessary for effective classroom presentations.

Chapter 3

- The essential features of microbial metabolism necessary for understanding how microorganisms transform energy are laid out in a logical sequence with an appropriate level of detail on metabolic diversity for introductory students. Newly rendered art makes mastering key metabolisms a more visual and engaging experience.

Chapter 4

- The basic principles of molecular microbiology are heavily revised and beautifully presented early in the text to provide a useful background for students as they proceed through the book.
- Beautiful new art stresses consistency and simplicity to make complex molecular concepts easy to learn, retain, and apply.

Chapter 5

- To close Unit 1, this chapter draws on the previous four chapters in describing the end result of molecular biology and physiology: cell division and population growth.
- The chapter now incorporates the essentials of microbial growth control to allow instructors to better tie important practical content to the basic science of the growth process itself.

Chapter 6

- Complete coverage of microbial genomics and the omics revolution that is driving the science of microbiology today appears much earlier in the book than in the previous edition. Coverage of the technology, biology, and evolution of genomes is laid out in a new and exciting fashion.
- Marvel at the power of genomics in a new Explore the Microbial World feature on single-cell genomics: "Genomics, One Cell at a Time."

Chapter 7

- Chapter 7 contains major updates on the regulation of gene expression—one of the hottest areas in microbiology today—including expanded coverage of cell sensing capacities and signal transduction.
- Explore new aspects of gene regulation, including the importance of small RNAs and the regulation of special events in model bacteria such as sporulation in *Bacillus*, cell differentiation in *Caulobacter*, and heterocyst formation in the nitrogen-fixing cyanobacterium *Anabaena*.

Chapter 8

- The basic principles of virology are presented without extraneous detail and use bacteriophage T4 as a model for depicting key virological concepts.
- New coverage of the virosphere and viral ecology reveals the overwhelming genetic diversity of viruses.

Chapter 9

- Coverage of viral genomes and diversity now directly follows the basic virology chapter to better link the two closely related topics.
- New coverage of the evolution of viral genomes and a new organization that more directly contrasts the biology of DNA and RNA viruses support a more consistent and conceptual understanding of viral diversity.

Chapter 10

- Coverage of the fundamental principles of the genetics of *Bacteria* and *Archaea* is now strategically located in the book to better incorporate supporting concepts from molecular microbiology, growth, regulation, and virology.

Chapter 11

- Complete coverage of the molecular biology of gene cloning and other major genetic manipulations forms a prelude to coverage of the application of these methods in the fast-moving field of biotechnology.
- Enter the world of synthetic biology and learn how this hot new area promises yet another revolution in biology.

Chapter 12

- Microbial evolution and systematics benefits from a major revision that focuses on the mechanisms of microbial evolution, including the importance of genomic evolution and horizontal gene transfer.
- Consider how metabolic interdependencies in microbial communities may have evolved in a fascinating new Explore the Microbial World feature, "The Black Queen Hypothesis."

Chapter 13

- Microbial metabolic diversity is now presented in a single chapter to better compare and contrast the key metabolisms of *Bacteria* and *Archaea* and to emphasize how "the unity of biochemistry" has pervaded microbial metabolism.
- Metabolic diversity is now strategically positioned to naturally segue into the new chapter on bacterial functional diversity.

Chapters 14 and 15

- Chapter 14, "Functional Diversity of *Bacteria*," now explores bacterial diversity with respect to the ecological, physiological, and morphological characteristics of well-known bacteria. Chapter 15, "Diversity of *Bacteria*," presents the diversity of bacterial life in a truly phylogenetic context. New, colorful, and easy-to-follow phylogenetic trees summarize bacterial diversity in both chapters.

Chapter 16

- Archaeal diversity is revised with a stronger phylogenetic thread and new coverage of the more recently discovered archaeal phyla of *Thaumarchaeota*, *Nanoarchaeota*, and *Korarchaeota*.
- Learn how the previously unrecognized *Thaumarchaeota* are probably the most common *Archaea* on Earth and review the physicochemical limits to life, all of which are currently defined by species of *Archaea*.

Chapter 17

- Eukaryotic microbial diversity benefits from new phylogenetic coverage and a chapter prelude on the importance of endosymbioses in the evolution of eukaryotic cells.
- Many new color micrographs portray the beauty and diversity of eukaryotic microbial life.

Chapter 18

- The modern tools of the microbial ecologist are described with examples of how each has sculpted the science. Also, learn how the omics revolution has provided a new window for simplifying complex problems in microbial ecology.
- In the new Explore the Microbial World feature "Culturing the Uncultured," discover how novel ecological methods have yielded laboratory cultures of the marine bacterium *Pelagibacter*, the most abundant organism on Earth.

Chapter 19

- The properties and microbial diversity of the major microbial ecosystems are compared and contrasted in an exciting new way.
- New environmental census data for freshwater habitats and the microbial ecology of arid landscapes highlight new material in this chapter, along with fresh coverage of the link between marine microorganisms and climate change.

Chapter 20

- Chapter 20 includes new coverage of the remarkable abilities of microorganisms to respire solid metal oxides in the iron and manganese cycles.
- Learn how humans are profoundly affecting the nitrogen and carbon cycles, including inorganic nutrient overloads and other forms of pollution, and how all of this feeds back into climate change.

Chapter 21

- A new chapter on the "built environment" shows how humans create new microbial habitats through construction of buildings, supporting infrastructure, and habitat modification. Witness the substantial positive and negative effects microorganisms have on important human infrastructure including wastewater treatment, microbial mining and acid mine drainage, corrosion of metals, the biodeterioration of stone and concrete, and the problem of pathogens in drinking water.

Chapter 22

- Here you will find expanded coverage of how microorganisms profoundly affect the physiology of plants and animals through symbiotic associations, including the dynamic topic of the human microbiome and its relationship to health and disease.
- Discover how a common mechanism used by bacteria and fungi to form symbiotic associations with the roots of plants provides the plants with key nutrients.

Chapter 23

- Major topics in human microbiology including the normal microflora, pathogenesis, and host factors in infection and disease are presented in a style that unites these concepts and reveals how they tip the balance toward health or disease.

Chapter 24

- Chapter 24 is designed to be the straightforward and concise overview of immunology that many instructors use to teach the fundamental concepts of the science.
- This chapter is loaded with practical information on vaccines, inflammation, and allergic responses in an easily teachable format.

Chapter 25

- Built on the shoulders of the previous chapter, Chapter 25 offers a more complete picture of immune mechanisms, with an emphasis on the molecular and cellular interactions that control innate and adaptive immunity.

Chapter 26

- This is a brief chapter that considers immunology from a completely molecular perspective, including the important receptor–ligand interactions that trigger the immune response and the genetics of the key proteins that drive adaptive immunity.

Chapter 27

- Reorganized and up to date, Chapter 27 describes the role of the clinical microbiologist and introduces the tools used to identify and track infectious diseases in clinical laboratories.
- New coverage of antimicrobial agents and their clinical usage underscores the important role of both drug therapy and drug resistance in medicine today.

Chapter 28

- A revised discussion of epidemiology introduces the concept of the reproduction number (R) and its implications for disease spread and control by herd immunity.
- Find up-to-date coverage of emerging infectious diseases and current pandemics, including those of HIV/AIDS, cholera, and influenza, and the role of the epidemiologist in public health microbiology.

Chapter 29

- Coverage of diseases transmitted from person to person is reorganized and illustrated with dozens of new color photos showing symptoms and treatments. To better consolidate material that fits a common theme, infectious diseases in this and each of the next three chapters are presented by taxonomy.

Chapter 30

- Bacterial and viral diseases transmitted by insect vectors or from soil are consolidated and illustrated by dozens of new color photos.
- This chapter contains new coverage of important viral diseases such as yellow fever and dengue fever and the bacterial diseases anthrax, tetanus, and gas gangrene.

Chapter 31

- Common-source diseases linked to contaminated food and water are now consolidated to better emphasize their similar modes of transmission. Coverage within the chapter is by taxonomy—bacterial versus viral—and illustrated with nearly 30 new color photos.
- Find new coverage of the potentially fatal foodborne infection caused by the intracellular bacterium *Listeria*.

Chapter 32

- All infectious diseases caused by eukaryotic microorganisms—fungi and parasites—are consolidated into one chapter to retain the taxonomic theme of medical microbiology. The visual experience is bolstered by 35 new color photos showing the pathogens and disease symptoms. Coverage of fungal and microbial parasitic diseases is expanded; the chapter also includes first-time coverage of major helminthic infections.

Other Learning Tools

- Two appendices, including a primer on bioenergetic calculations and a list of higher order taxa described in *Bergey's Manual of Systematic Bacteriology*; a glossary; and a thorough index round out the learning package in *Brock Biology of Microorganisms*, 14e.