

Preface

When I was approached by Jones & Bartlett Learning to become the new author of Alcamo's *Microbes and Society, Fourth Edition*, I was delighted. Why? It certainly wasn't because I was looking for more to do. With authoring other college textbooks and having a full-time faculty teaching position at Glendale Community College, I am plenty busy. The actual reason was that I saw this as an opportunity to convey the excitement and wonder of microbes to college students not majoring in the sciences, and to the public.

Today, hardly a day goes by when a story about microorganisms (microbes) does not appear in a newspaper, magazine, or on the TV news. When we see or hear a report on a disease outbreak, the discovery of some new and often exotic microorganism, or a news story about how microorganisms influence our good health and the environment, many students and the public in general often do not have the background to properly evaluate many of the statements or claims made. After reading *Microbes and Society*, all that will change.

It is an exciting time in microbiology, so I see my charge as one to capture that excitement, and transform the reader into a knowledgeable and scientifically literate citizen in today's society. This is not to make you into a science nerd, although there is nothing wrong with that, but rather to illustrate how the science of microbiology affects all of us in tremendous ways. As citizens of the world, we need to understand how the science operates, the challenges it faces, and the discoveries being made. Today, microbes are important to our lives, our good health, our society, and the daily operation of the world around us.

So, welcome to the world of microbiology! I hope you find the journey exciting, enriching, informative, and fascinating.

Audience

Alcamo's *Microbes and Society, Fourth Edition* is written to the nonscience undergraduate and inquiring citizen of the 21st century. It discusses such topics as the place of microbes in ecology and the environment, the use of microbes in biotechnology, the role of microbes in food production, and the numerous other ways that microbes contribute to the quality of our lives and our wellbeing. The book also examines the problem of antibiotic resistance, discusses the problems of nosocomial infections, and surveys several microbial diseases of history and contemporary times. Students will find that understanding microbes will help them do well in such fields as business, sociology, food science, pharmaceutical and health sciences, economics, and agriculture. The book assumes little or no science background, and it should accommodate one-quarter or one-semester courses.

Objectives

The 21st century is destined to be the Century of Biology. In future decades we can anticipate new products of biotechnology, new ways of preserving and protecting our environment, new methods in agriculture, new practices to maintain human health, and new technologies not yet even in the idea stage. And importantly, microbes are at the center of all of these. They are the hammers and nails of genetic engineering, the worker bees for purifying polluted water, the sources of imaginative insecticides and pesticides, our internal guardians protecting us from disease and helping keep us healthy, and the jumping off points for futuristic technologies. Knowing the microbes is essential to knowing the future. Helping you to know the microbes is the first major objective of this book.

What of today? Rarely does a day go by when we do not enjoy a "microbial food;" each time we put out the garbage, we assume that microbes will break it down; whenever we take a breath, we inhale oxygen that microbes have put into the atmosphere; and each time we cover a sneeze, we try to stop the spread of microbes. Helping you to understand the places that microbes occupy in our day-to-day existence is this book's second major objective.

But what would the present and future be without the past? The third major objective is to show you how microbes have had a significant impact on history. We shall study, for example, how microbes changed the course of Western civilization, how microbes stopped Napoleon's conquest of Russia, how microbes influenced the way cultures arose, and how microbes made much of the current work in biotechnology possible. Few groups of organisms have played such a rich and powerful role in history.

I hope you will enjoy your education in microbiology and come to understand the influence of microbes on our society today, in the past, and in the future.

Organization

Alcamo's Microbes and Society, Fourth Edition contains two parts. Part I introduces the microbial world over the span of 11 chapters. Individual chapters explore the bacteria, viruses, fungi, protists, and other microbes; other chapters describe how these microbes grow and reproduce, the unique genetic patterns they display, and the methods used to control them.

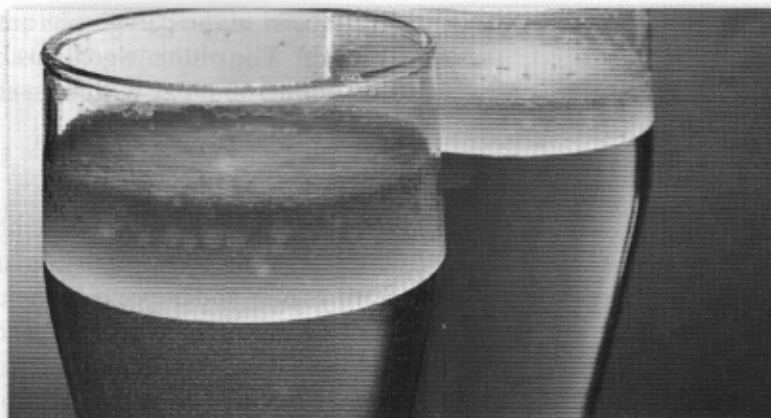
Part II moves to the practical applications of microbiology. We visit a restaurant for a microbial meal, we wander through a research facility and see microbes at work, we stop at various locations in the environment and observe microbes acting on our behalf, and we examine their place in disease. The bottom line is that microbes are relevant.

Must the chapters be studied in sequence? Absolutely not. Time constraints often prevent courses from using the entire book, so instructors and students are invited to "cherry pick" those topics that fit best. To encourage flexibility, each chapter has been written independently of the others, and each section in a chapter stands alone. Instructors may, therefore, design their own approach to microbiology according to their students' needs.

The Student Experience

Approaching a course in microbiology can be an anxious experience. There are new insights to learn, new concepts to master, and an entirely new vocabulary to memorize. To help smooth over the bumps, this book incorporates several features that should help increase students' comfort level as they read *Alcamo's Microbes and Society, Fourth Edition*.

Each chapter begins with a section titled “Looking Ahead” to let students know what they should take away from the chapter. The reading then opens with an engaging story to set a tone for the pages that follow. Key terms in the chapter appear in bold to draw the attention of readers, and organism pronunciations (sometimes appearing to be tongue twisting names) appear in the chapter margins along with the definitions of some more specialized terms (see margin). In addition, a pronunciation guide has been added as an Appendix.



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Microbes and Food: A Menu of Microbial Delights

Many food and beverage products we consume and enjoy every day are either created by certain species of microbes or they are part of the production process in making the commercial product.

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Looking Ahead

Although we often think of microbes as food contaminants, many species actually play vital roles in producing the foods we enjoy, as we will discover in this chapter.

On completing this chapter, you should be capable of:

- Describing the process of wine fermentation.
- Comparing the roles of microbes in the fermentation processes for olives and cheese making.
- Explaining the role of yeast in bread making.

...ing the fermentation process for sausages and sauerkraut, ... the process of brewing beer.

...he decades, many food-related microbes have received bad ... numerous disease outbreaks associated with ... although no ...

... have been ... en received ... this nega- ... microbes ... associated ... condemn-

Endospores

A few bacterial species, particularly members of the genera *Bacillus* and *Clostridium*, have the ability to produce an extraordinarily resistant structure called the **endospore**. This structure is usually formed during an unfavorable environment. The spore is formed during an unfavorable environment in which the mother cell produces an internal spore (i.e., endospore) that contains a complete set of genetic information surrounded by a very thick peptidoglycan set of walls. Once formed and mature, the dormant spore is released with the death of the mother cell.

Endospores are probably the most resistant biological structures known. Desiccation has little effect on the spore. By contrast, most bacteria are heat resistant and undergo very few chemical changes. For example, endospores can remain viable in 70% ethyl alcohol, endospores can barely withstand 500 rads of radiation, but centuries.

■ *Bacillus*
ba-CT-us

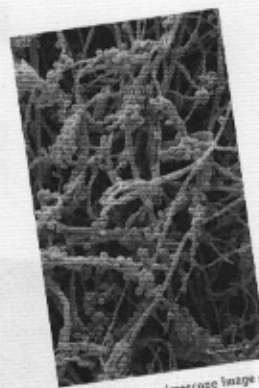
■ *Clostridium*
klos-tri-dee-um

■ rads (Roentgen Equivalent in Dose): A measure of radiation dose related to biological effect.

CHAPTER 11 A CLOSER LOOK 11.4 Hiding a Treasure

Their timing could not have been worse. Howard Florey, Ernst Chain, Norman Heatley, and others of the team had rediscovered penicillin, purified it, and proved it useful in infected patients. But it was 1939, and German bombs were falling on London. This was a dangerous time to be doing research into new drugs and medicines. What would they do if there was a German invasion of England? If the enemy were to learn the secret of penicillin, the team would have to destroy all their work. So, how could they preserve the vital fungus yet keep it from falling into enemy hands?

Heatley made a suggestion. Each team member would rub the mold on the inside lining of his coat. The *Penicillium* mold spores would cling to the rough coat surface where the spores could survive for years (if necessary) in a dormant form. If an invasion did occur, the mold would be used to start new cultures and the research could continue. Of course, a German invasion of England did not occur, but the plan was an ingenious way to hide the mold.



False-color scanning electron microscope image of *Penicillium* spores and hyphae. (Bar = 10 μ m.)
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A Final Thought

When one of us (J.P.) was a young assistant professor of biology, the question of whether viruses are “alive” came up for discussion at an informal social gathering. As several people had had some beer to drink, the conversation became quite animated supporting one or the other viewpoint on viruses being alive. Perhaps one of the best answers was, “Who cares? We treat viral diseases the same way regardless of whether they are alive or not.”

But the question has continued to pique my interest philosophically to this day. And now I put it to you. Are viruses alive? Although this textbook often refers to viruses as microbes for the sake of convenience, we have avoided references to “live” or “dead” viruses. Instead, we have used the words “active” for replicating viruses and “inactive” for viruses not replicating. Perhaps we should consider viruses to be inert chemical molecules with at least two properties of living organisms—the ability to replicate and adapt. Thus, viruses are neither totally inert nor totally alive, but somewhere on the threshold of life. Your thoughts?

Special topics boxes in each chapter (“A Closer Look”) encourage a moment of relief from the rigors of study, and present a historical insight, an interesting aside, or a health issue. Most figures are presented in full color, and special attention has been given to setting them close to their text reference.

The chapter concludes with A Final Thought, a set of Questions to Consider that provide challenging opportunities to apply what has been learned, and a Key Terms list for review. Students may note that all chapters are about the same length. This was done purposefully to provide a symmetrical framework in which students can learn. Each chapter has several sections and numerous smaller subsections to accommodate limited study times.

Even many of the paragraphs are about the same size (there should be a rhythm in reading). The ultimate goal has been to provide a thorough and balanced presentation of microbiology within an enjoyable context.

What's New in This Edition?

Microbiology is a dynamic science and so this fourth edition reflects many of these advances as they pertain to humans, the environment, and society. The textbook also features new, and improved schematics to represent essential concepts and paradigms of thought in a more accurate and approachable way.

Each chapter has been revised based on the most current and significant knowledge available. New to this edition is:

- Updated coverage of microbes and new information on the human microbiome (Chapters 1 and 2).
- Revised coverage of microbial molecules (Chapter 3).
- Clearer descriptions of genes and the science of genomics (Chapter 4).
- New information on viruses and all microbial groups (Chapters 5–8).
- Revised descriptions of bacterial growth and metabolism (Chapter 9).
- Current applications of genetic engineering and biotechnology (Chapters 10 and 14).
- New discussions on bacterial resistance to antibiotics (Chapter 11).
- Expanded coverage of food microbiology, safety, and prevention. (Chapters 12 and 13).
- Expanded coverage of vaccines and their importance to human health (Chapter 14).
- New data on microbes in agriculture and the environment (Chapters 15 and 16).
- Clearer discussions of the immune system function (Chapter 17).
- More concise descriptions of viral and bacterial diseases (Chapters 18 and 19).

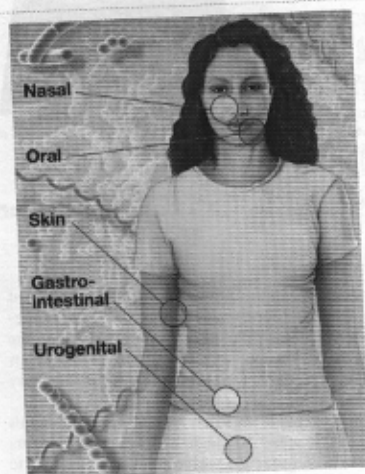
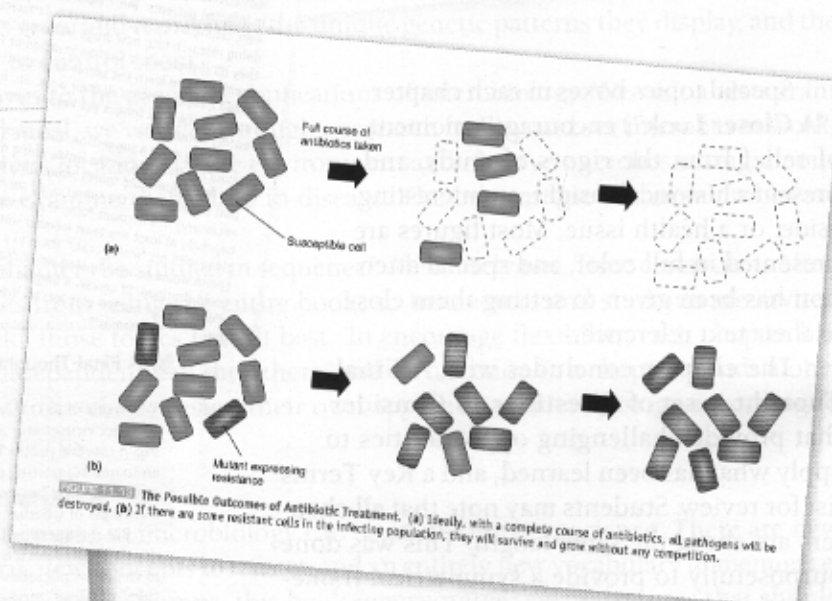


FIGURE 1.5 The Human Microbiome Sites. This image identifies the body sites that were examined and sampled from 244 volunteers for the Human Microbiome Project.

Courtesy of NIH Medical Arts and Printing.



All chapters have a small number of special topics boxes that are interesting, intriguing, and often important to us, and society as a whole. Some of these boxes have been updated or replaced. Among the new boxes are:

1.3 Antibiotics in the Feedlots	The abuse of antibiotics in fattening up livestock
2.4 Size Matters	Cell size is critical for proper nutrient transport
3.3 Microbes to the Rescue!	Microbes help clean up the <i>Deepwater Horizon</i> oil spill
4.2 The Tortoise and the Hare	Personalities affect the search to identify the structure of DNA
5.4 The Blood of History	Microbes have caused some "bloody" miracles in history
6.4 The Power of the Virus	Engineered viruses help to cure genetic diseases
7.4 "Black '47"	A microbial plant disease changes history
8.3 The Work of the Devil	Fungal hallucinations were behind the Salem witchcraft trials
9.3 Microbes "Raise a Stink"	Microbes compete successfully by being offensive to others
10.2 Gene Swapping in the World's Oceans	Microbes undergo an amazing amount of gene recombination
11.3 Are Antibacterial Soaps Worth the Money?	Investigating the reported usefulness of antibacterial soaps
12.3 This hqt's for You!	Ancient beer making by the Egyptians
13.3 Keeping Microorganisms Under Control	Quizzing your food safety precautions at home
14.1 Tag Team Microbes	Microbes working together can produce successful results
15.2 Stilton Cheese—Slicing through a Microbial Community	Some bacteria and fungi are essential to making many cheeses
16.2 The Great Sanitary Movement	Edwin Chadwick and the birth of modern sanitation
17.1 Probiotics and Your Health	Bacteria, probiotics, and their role in human health
18.4 The HIV Hideouts	Where the AIDS virus can hide out in the body
19.1 The Killer of Children	Pneumonia is deadly to children in many developing nations

Teaching Tools

The following resources are available to instructors to assist with course preparation:

- Sample Syllabus
- Lecture Outlines
- In-depth Lecture Presentations in PowerPoint format that feature art from the book
- Test Banks

- Image Bank of figures from the book
- Answers to the end-of-chapter questions from the book

Qualified instructors can obtain this material by contacting their Jones & Bartlett Learning Account Specialist or by going to www.jblearning.com.

Jones & Bartlett Learning also publishes the following titles that may be of use for your microbiology course:

- *Infectious Diseases: The Guide to Infectious Diseases by Body System, Second Edition* is an excellent ancillary 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.
- *Encounters in Microbiology: Encounters with Microbiology, Volume I, Second Edition* and *Volume II* bring together "Vital Signs" articles from *Discover* magazine in which health professionals use their knowledge of microbiology in their medical cases.

Note to Instructors

Microbiology embodies the beautiful and ugly, the simple and complex, and the big and the small of life, and in this regard is a fascinating, useful, and approachable topic for non-science majors to learn. Because of the real value of microbes to the quality of human life, the environment, and society, as well as their ability to cause disease, I saw the need for a course in microbiology for the non-science major. *Alcamo's Microbes and Society, Fourth Edition* is written and designed to support such a course; I hope you find it to be a useful tool in your pedagogical mission.

Please feel free to email me (jeffrey.pommerville@gccaz.edu) anytime with questions, comments, ideas, and/or suggestions that you believe could strengthen this text and make it an even more exciting learning experience for students.

Additional Microbiology Resources from Jones & Bartlett Learning

The following additional products are available to supplement your microbiology course. Our full catalog can be browsed at go.jblearning.com/Microbiology

- *Alcamo's Laboratory Fundamentals of Microbiology* is a series of 30 multipart laboratory exercises that provide basic training in the handling of microorganisms and help students understand the properties and uses of microbes.
- A two-volume anthology called *Encounters in Microbiology* brings together "Vital Signs" articles from *Discover* magazine in which health professionals describe in layman's terms their experiences with microbes and their knowledge of microbiology to solve medical mysteries.
- *Guide to Infectious Diseases by Body System, Second Edition* is an excellent tool for learning about microbial diseases. Each of the 15 body system units in the booklet presents a brief introduction to the anatomical system and a sampling of the bacterial, viral, fungal, or parasitic organisms that can infect the system.