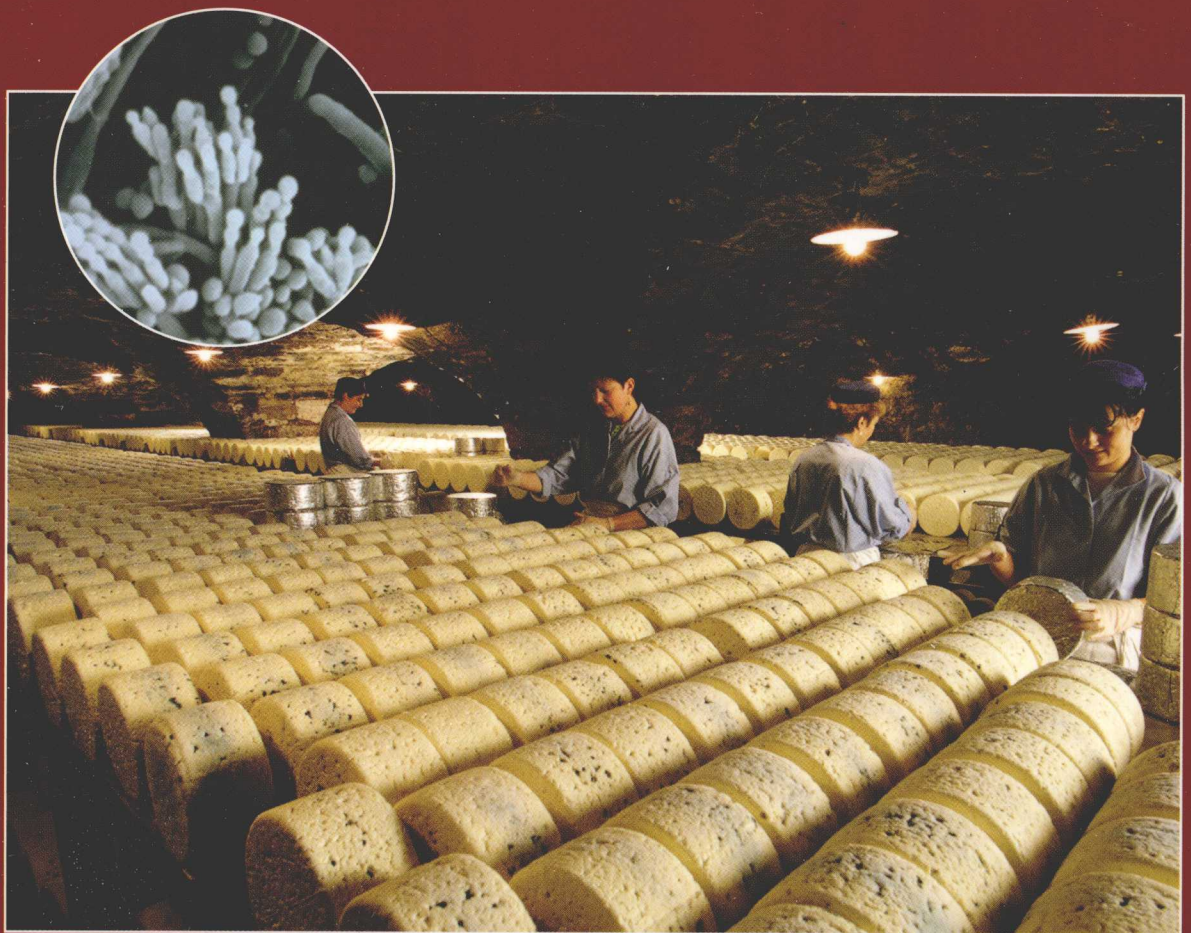


# MICROBES AND SOCIETY

SECOND EDITION



BENJAMIN S. WEEKS  
I. EDWARD ALCAMO

# MICROBES AND SOCIETY

SECOND EDITION

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#### About the Cover

French cheese makers wrap Roquefort cheese in the natural caves of Roquefort-sur-Soulzon. The cheese is made from the milk of a single breed of sheep, the Lacaune, and seeded with *Penicillium roqueforti* spores. The mold, which grows naturally in the caves, gives the cheese its bluish color and distinctive aroma. Inset: A scanning electron micrograph of *P. roqueforti* hyphae with conidiophores (magnified 205x).

# MICROBES AND SOCIETY



## **The Jones & Bartlett Topics in Biology Series**

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Teri Shors, PhD, University of Wisconsin—Oshkosh

# Dedication

*I would like to dedicate this book to its first author, Professor I. Edward Alcamo, whom I never met in person, but met as a student of his writing and now through the honor of continuing his work. Here's to you, Professor Alcamo.*

*I would also like to dedicate this book to my wife, Melissa, who has provided me with undying love and support, and my children, Samuel, Hayden, Jessica and David, who have provided me with endless joy and pride.*



# Preface

Rarely does a day go by when a story about microbes does not appear in a newspaper, magazine, or TV news show. What we see on these shows can influence our view of microbes, and each of us may have a different vision. Perhaps we see them as fearsome “germs” lurking about waiting to do us harm. Or perhaps we have heard that they are the biological factories in which the products of biotechnology are made. We may know them as producers of dairy products such as yogurt and sour cream or of fine wines and cheeses. Perhaps our vision is clouded by thoughts of microbes as agents of bioterrorism. Our vision of microbes likely comes from limited knowledge of them. If so, then we are about to broaden our spectrum because this book will take us on an extended tour of the microbial world. We’ll see the remarkable variety among microbes; we’ll experience the myriad ways they help maintain life on Earth; and we’ll explore the marvelous jobs they perform for us and the not-so-marvelous ways they cause illness. In the end we may even discover that our new view of microbes is quite unlike the limited view we had before.

## Audience

*Microbes and Society, Second Edition* is geared to the informed citizen of the 21st century. It discusses such topics as the place of microbes in ecology and the environment, the uses 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. The book also explores bioterrorism, examines the problem of antibiotic resistance, 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 genetic engineering, new ways of preserving and protecting our environment, new methods in agriculture, and new technologies not yet even in the idea stage. And 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, and the jumping off points for futuristic technologies. Knowing the microbes is essential to knowing the future. And knowing the microbes is the first major objective of this book.

What of today? Consider these thoughts: 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 the oxygen that mi-



crobes have put into the atmosphere; and each time we cover a sneeze, we try to stop a microbial disease from spreading. All of which brings us to this book's second major objective: understanding the places that microbes occupy in our day-to-day existence.

And what would the present and future be without the past? So the third major objective is showing how microbes have had a significant impact on history. We shall study, for example, how microbes changed the course of Western civilization, how microbes helped Alexander the Great conquer Asia, how microbes influenced the ways cultures arose, and how microbes made much of the current work in genetic engineering possible. Few groups of organisms have such a rich and powerful place 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.

### **What's New?**

The second edition of *Microbes and Society* contains updates, additions, reorganization, and new features. For example, this second edition includes information on recent *E. Coli* outbreaks, the emergence of antibiotic resistant bacteria, new updated epidemiology on rates of disease, and a furtherance on the uses of bacteria in biotechnology. Additionally, this second edition contains a new Chapter 3 on the "Molecules of the Cell: The Building Blocks of Life." In keeping with the spirit of this book, this material is presented on the introductory level and presented with clarity and simplicity. By providing this new chapter, both the student and professor can explore the remaining chapters of the book with a deeper scientific foundation. The second edition has also been slightly reorganized so that the chapters flow between related topics more directly. A glossary and pronunciation guide have also been added to assist the reader. In all, the second edition is an up-to-date, in-depth exploration of the many facets of microbiology and how microorganisms touch our lives, in ways both good and bad, on a daily basis. This book maintains a scientific foundation and basis while also bringing to life the impact of microbes on society.

### **Organization**

The second edition of *Microbes and Society* contains two parts. In Part I, we introduce the microbial world over the span of nine chapters. Some of the chapters explore the bacteria, viruses, fungi, protozoa, and other microbes; and 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 places in disease. The bottom line is that microbes are relevant.

Must the chapters be studied in sequence? Absolutely not. We understand that time constraints often prevent courses from using the entire book, so we invite instructors and students to 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.

## Special Features

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 smooth over the bumps, we have incorporated several features that should help increase the comfort level of *Microbes and Society*.

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 have been boldfaced to draw the attention of readers, and pronunciations of difficult terms are presented in the margins. Boxes in each chapter (“A Closer Look”) encourage a moment of relief from the rigors of study and present an historical insight, an interesting aside, or a current research direction. The 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 list of the key terms for review and a set of thought questions that provide challenging opportunities to apply what has been learned.

Students may note that all chapters are about the same length. This was done purposefully because we wanted 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 the paragraphs are about the same size (there should be a rhythm in reading). The bottom line is that we’re hoping to provide a thorough and balanced presentation of microbiology within an enjoyable context.

## Ancillaries to Accompany *Microbes And Society, Second Edition*

To assist you in teaching this course and supplying your students with the best in teaching aids, Jones and Bartlett Publishers has prepared a complete ancillary package available to all adopters of *Microbes and Society, Second Edition*. Additional information and review copies of any of the following items are available through your Jones and Bartlett Sales Representative.

### For the Instructor

#### Instructor's ToolKit CD-ROM

Compatible with Windows and Macintosh platforms, the Instructor's ToolKit CD-ROM provides adopters with the following traditional ancillaries.

The **Test Bank**, prepared by the author, is available as text files. The test bank contains over 1,200 questions. An additional set of test bank files is formatted for your own online courses using WebCT and Blackboard.

The **PowerPoint® Lecture Outline Slides** presentation package provides lecture notes, graphs, and images for each chapter of *Microbes and Society, Second Edition*. Instructors with the Microsoft PowerPoint software can customize the outlines, art, and order of presentation. The PowerPoint files have also been prepared in HTML format for use in online course management systems.

The **PowerPoint Image Bank** provides the illustrations, photographs, and tables (to which Jones and Bartlett Publishers holds the copyright or has permission to reprint digitally) inserted into PowerPoint slides. With the Microsoft PowerPoint program, you can quickly and easily copy individual images into your existing lecture slides. If you do not own a copy of Microsoft PowerPoint or a compatible software program, a Microsoft PowerPoint Viewer is included on the CD-ROM.

The answers to the “Questions to Consider” are also on the CD-ROM.



### For the Student

We have developed a website (<http://microbiology.jbpub.com/book/microbes>) exclusively for *Microbes and Society, Second Edition*. The site contains a free student study guide that includes chapter outlines, flash cards, and quizzes. The site also provides research and reference links, and links to microbiology in the news.

**Laboratory Fundamentals of Microbiology, Eighth Edition**, is a series of over 30 multi-part laboratory exercises providing basic training in the handling of microorganisms and reinforcing ideas and concepts described in the textbook.

**Encounters with Microbiology** brings together “Vital Signs” articles from *Discover Magazine* in which health professionals use their knowledge of microbiology in their medical cases.

**Guide to Infectious Diseases by Body System**, by Jeffrey C. Pommerville, Glendale Community College, is an excellent tool for learning about microbial diseases. Each of the fifteen body system units presents a brief introduction to the anatomical system and the bacterial, viral, fungal, or parasitic organism capable of infecting the system.

**20th Century Microbe Hunters**, by Robert Krasner, Providence College, offers a dramatic portrayal of the achievements and lives of microbiologists such as Charles J. Nicolle (typhus epidemic), Barry Marshall and J. Robin Warren (*Helicobacter pylori*), Luc Montagnier and Robert Gallo (HIV), and Donald R. Hopkins (Guinea worm).

**How Pathogenic Viruses Work**, by Lauren Sompayrac, is a concise summary of the basics of virology written in an understandable and entertaining manner. The book is composed of nine lectures covering the essential elements of virus-host interactions with descriptive graphics, helpful mnemonic tactics for retaining the concepts, and brief lecture reviews. This is an ideal text for medical, science, and nursing students who want a review, or simple explanation, of virology.

### Acknowledgments

Professor Alcamo, along with those at Jones and Bartlett Publishers, envisioned the need for a book on the topic of microbiology for the non-science major. I am honored and grateful to have been given the opportunity by Cathleen Sether to continue Ed Alcamo's work by updating and extending the material for the second edition of this book. I want to thank the rest of my “family” at Jones and Bartlett Publishers, Daniel Stone, Shoshanna Grossman, Molly Steinbach, Dean DeChambeau and Lou Bruno for their encouragement and support through the process of bringing this second edition together. I would also like to thank Donald G. Lindmark of Cleveland State University and Linda Bruslind of Oregon State University who took valuable time to offer their suggestions for improving this edition.

### A Note From the Author

I completed my doctoral training in 1988, investigating mechanisms through which environmental pollutants can cause disease in humans. My real interest in microbiology did not take shape until 1997 with my arrival at Adelphi University. With training in virology and immunology, I was asked to lead the microbiology course for our nursing majors, a course that focuses on the infections and diseases that these “nasty” bacteria cause in humans. One of my favorite laboratory exercises for the nursing microbiology course is to have the students wash their laboratory bench top with deter-



gents and disinfectants and then sample the cleaned bench top immediately, and over several hours, for the presence of bacteria. Invariably more than half of the class finds bacteria still present even at time zero with increases in cultivable bacteria over the following hours. The students are also amazed, as am I despite repeated experience, that at least one student each semester will culture a bacteria from the environment that is resistant to all antibiotics tested against it. My interest in bacterial samples from the environment quickly turned to the soil. My students and I were imagining all the antibiotic resistant bacteria in the ground that school children must be playing and rolling around in. However, this line of investigation actually led me to the “other side” of microbiology and back home to my roots as an environmental scientist. Bacteria are not just infectious agents that cause disease; the bacteria in the soil, as decomposers, play a vital role in the cycle of life. I went digging for germs, but I found a treasure! One to be cared for.

While my own research and recent reports raised concerns that pesticides could cause neurodegenerative disease in people, my concerns were now also with the effects of insecticides and their mixtures on the bacteria that make the soil their home. Disruption of soil micro-organisms with pesticides and other pollutants could have a devastating effect on soil health and crop production as well as disturb a fundamental balance in the ecosystem. Indeed, my laboratory is demonstrating that soil bacteria are susceptible to environmental pollutants such as pesticides and while bacteria can cause disease, poisoning bacteria in the environment may not only be the equivalent of poisoning ourselves, but is also ecologically and environmentally unsound.

In addition to having a valuable position in our ecosystem, bacteria are also valuable in the production of foods and beverages and are also vital in the production of vaccines and other medicines, including antibiotics. Further, bacteria have proved to be an essential tool for molecular biologists who are engaged in projects that range from gene therapy to genetically modified produce. Because of the real value of bacteria to the quality of human life, as well as their ability to cause disease, I saw the need for a course in microbiology for the non-science major. 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 as well as being the same for scientists and professors as a tool to teach non-science majors.

In the development of my microbiology course for non-science majors, “Microbiology: The Biological Basis,” I searched for an appropriate book and found Professor Ed Alcamo’s, *Microbes and Society*. I was delighted to find that Professor Alcamo had prepared a book that covered the good and bad of microbiology with a solid infusion of science. I found *Microbes and Society* to be in most ways an ideal companion for my course. While I never met Professor Alcamo, I came to know his genuine interest in educating people about AIDS and HIV through his book *AIDS: The Biological Basis*, of which I have been honored to become a part. It is therefore a great honor to have the opportunity to continue to develop *Microbes and Society*, with a second edition built upon the foundation of Professor Alcamo’s work.

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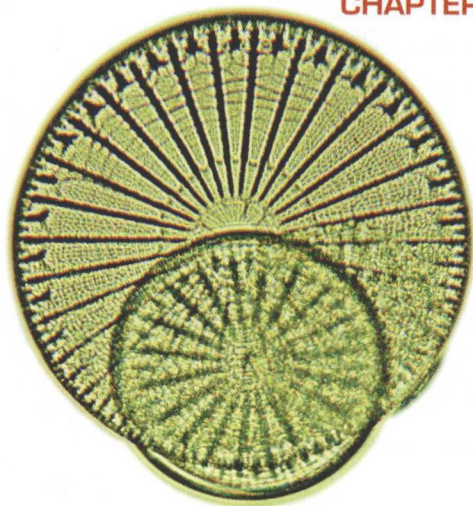
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