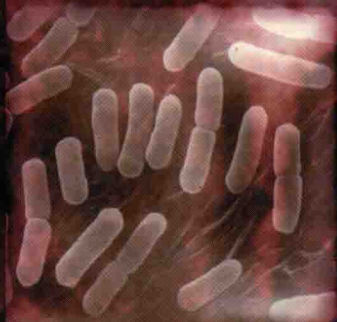


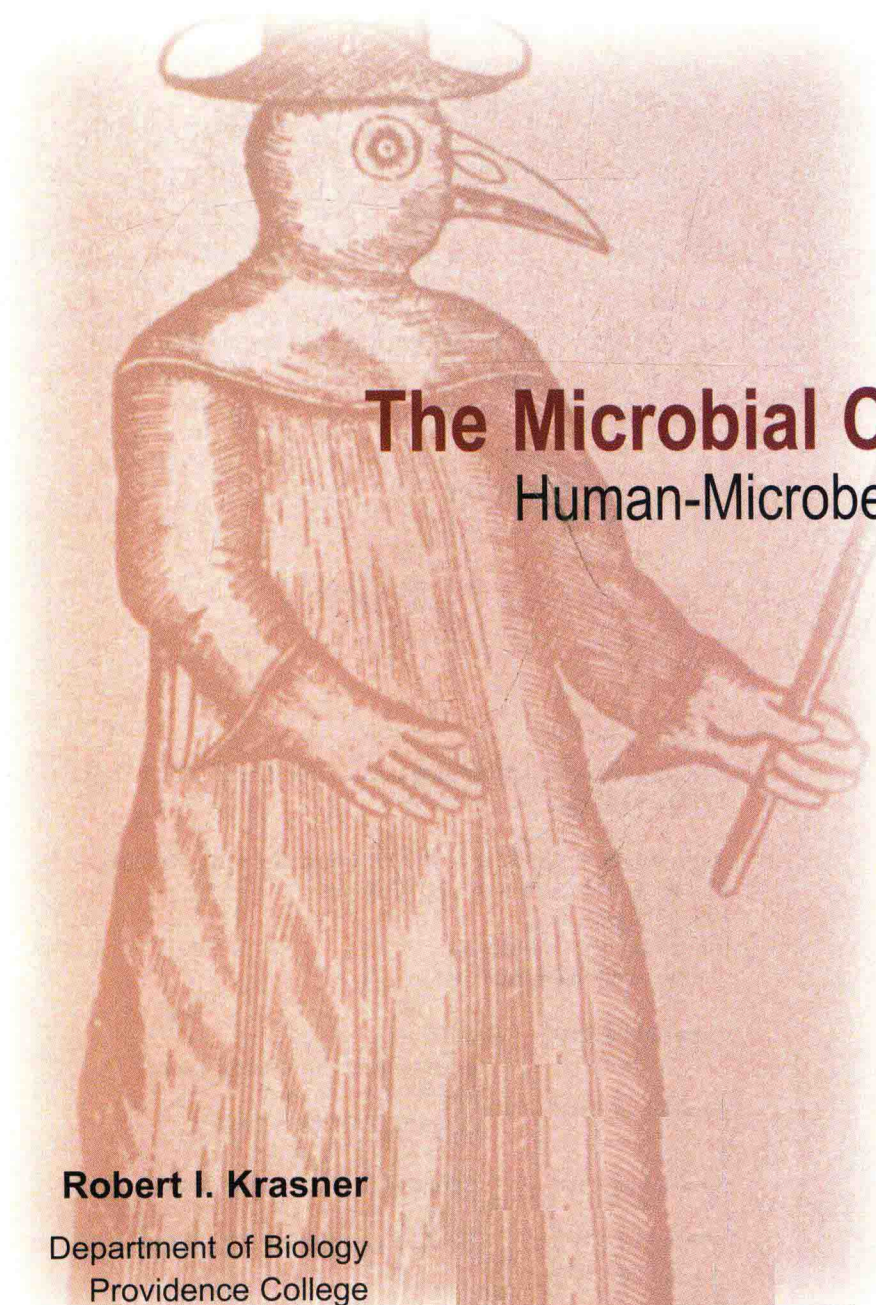
THE MICROBIAL CHALLENGE

Human-Microbe Interactions

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Robert I. Krasner



The Microbial Challenge

Human-Microbe Interactions

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The Microbial Challenge

Human-Microbe Interactions

To Lee
With gratitude for our life of love, happiness, and adventure
and
to our children and their spouses
and
their children

Acknowledgments

Writing a textbook is a difficult task—more so than I had thought. It is an ongoing collaboration between the author and the publisher requiring trust and mutual respect. I thank those staff members of ASM Press who have helped to transform my manuscript into a finished text of which we are all proud. In particular, I thank Jeff Holtmeier (director, ASM Press) and Ken April (senior production editor). In addition, I thank other ASM staff members who played roles in the publication process, as well as Mary McKenney, the copy editor; Susan Schmidler, who designed the interior of the book; and Patrick Lane and his staff at J/B Woolsey Associates, who prepared the illustrations and In the News pieces. I greatly appreciate their efforts.

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Introduction

New, emerging, and reemerging infections are a major public health problem today, yet 35 years ago, it was predicted that infectious diseases would soon be conquered. Accounts of infectious diseases currently appear almost daily in newspapers and in popular magazines; flesh-eating streptococci, *Escherichia coli*-contaminated strawberries, *Salmonella* disease, Ebola virus, mad cow disease, and AIDS top recent headlines and conjure up frightful images. Several excellent books, including *The Hot Zone* and *The Coming Plague*, have appeared in bookstores. Several years ago the movie *Outbreak* captured the public's interest. News stories warn of the continued threat of the use of biological weapons. In the days after the terrorist attacks on the World Trade Center and the Pentagon, anthrax spores were strategically disseminated to individuals in the government and the media, resulting in a large number of cases of anthrax, some of which proved to be fatal.

Had newspapers been available in ancient times, hieroglyphics would have revealed infectious diseases. Descriptions of what are probably leprosy and tuberculosis appear in the Bible. This is not surprising; after all, microbes were the first inhabitants of the earth, as evidenced by the fact that fossils dating back 3 billion years are those of primitive bacteria.

TEXT OVERVIEW

This text is divided into three parts in a logical sequence. Part I, "The Challenge," comprises chapters 1 to 10; part II, "Meeting the Challenge," comprises chapters 11 to 13; and part III, "Current Challenges," comprises chapters 14 to 16). Chapter 1 introduces the challenge posed by new, emerging, and reemerging microbial diseases, a challenge made more difficult by several factors, including increased urbanization, jet travel, the misuse of antibiotics, and cultural and societal changes. In chapter 2, the array and the biology of microbes are presented in the context of basic biological principles. Chapter 3 emphasizes that disease-producing microbes represent only a very small piece of the microbial pie. Microbes are not "out to get us"; it is not in their best interest. We are just fortuitous hosts

who manage to get in the way, and we become part of their food chain. Many microbes are beneficial to humankind. Harnessing them for even greater gain is a challenge. Chapters 4 and 5 present a more in-depth discussion of the biology of bacteria and viruses. The idea of parasitism as a biological association, under the umbrella of symbiosis, is introduced in chapter 6, which also focuses on the mechanisms of microbial virulence. Chapter 7 presents the cycle of microbial disease, with an emphasis on mechanisms of transmission. The major diseases caused by bacteria, viruses, and protozoa and helminths, arranged by modes of transmission, are presented in chapters 8, 9, and 10, respectively. At the conclusion of part I, the student will have the necessary background to meaningfully study chapters in the remaining two sections.

Part II deals with meeting the microbial challenge, a challenge which is present from birth (and before, in some cases). At the level of the individual, the challenge is met by the ability of the immune system to recognize and eliminate invading microbes; this is the subject of chapter 11. Chapter 12 focuses on public health achievements in the control of infectious diseases. The late 1800s and early 1900s ushered in the role of public health and sanitation; immunization and antibiotics became available during the 20th century. The watchwords of public health are surveillance and protection. The successes of the past century were the results of collaborative partnerships ranging from the local to the national and international levels; these partnerships are described in chapter 13.

Part III looks to the past in order to place current challenges in historical perspective. The coevolution and coexistence of microbes and humans from antiquity to current times have led to misery in the form of plagues that have decimated large populations and have affected the development of civilization, as discussed in part III. Chapter 14 is about biological weapons, a current challenge with an ancient history. This chapter covers the terrorist attacks of September 11, 2001, and the anthrax scare which followed in their wake. The fact that plagues cannot be relegated to the past but continue into the present is the basis for chapter 15, which presents mad cow disease, its human counterpart Creutzfeldt-Jakob disease, tuberculosis, and AIDS as examples of current plagues.

TEXT FEATURES

A text needs to be stimulating and user-friendly in order to engage the target audience. To this end, I have incorporated the following:

1. *In the News*: Imagine tomorrow's newspaper headlines if a tremendous breakthrough in the fight against AIDS, possibly a cure, were announced today. Newspaper articles and headlines reflect events of the day, including those concerned with public health. Over the past few years, I have clipped newspaper articles and headlines dealing with Ebola virus, AIDS, biological weapons, antibiotics, immunization, and a range of other public health topics. The material presented in "In the News" is adapted from actual headlines and news articles that I have collected.
2. *Photographs*: During my long tenure as a professor of microbiology, I have taken advantage of sabbaticals and leaves of absence to study infectious diseases. I have spent time in Central America, Israel, the

Pasteur Institute in Paris, and most recently Brazil (a trip highlighted by a field experience in the Amazon Basin). During my travels, I took many of the photos that are used to illustrate the text.

3. *Boxes*: Most chapters have one or more boxes. The intent is to present more information on subjects introduced in the narrative. Some boxes are of historical interest, whereas others are based on more contemporary issues.
4. *Layout*: The layout of the text is designed to help keep students focused and organized. Each chapter begins with a preview and ends with an overview, and an outline of the chapter is on the opening page. Section headings and subheadings are extensively used.
5. *Self-Evaluations*: A series of questions follows each chapter. The objective is to assist students in evaluating and reviewing the subject matter.

COURSE CONTENT AND STRUCTURE

The text is designed to allow maximum flexibility in course design. If the plan is to offer a one-semester course, the instructor can choose appropriate chapters (or parts of chapters) to meet his or her needs. Chapters 1 through 7 constitute a core and are preparatory for the remaining chapters. Some instructors may wish to stress pathogens and their diseases and may choose to cover all of the microbes presented in chapters 8, 9, and 10, while others may choose to sample from each mode of transmission in these chapters. If necessary because of time constraints, chapters 3, 11, and 14 could be skipped or assigned for self-study without compromising the flow of information. Certainly, other strategies can be developed, limited only by the instructor's ingenuity. The text can be used for a two-semester course as well, allowing time to supplement each chapter with additional readings, student presentations, guest lecturers, videos, and laboratory demonstrations and exercises that can be done in the classroom. This point is further addressed below.

LABORATORY COMPONENT

It is my expectation that in most cases, this book will be adopted for a course that does not include an assigned laboratory experience. However, there are a number of demonstrations and exercises that can be done in the classroom at nominal cost. Certainly, if a laboratory facility is available, it would be a good added feature. Examples include exercises to demonstrate the effectiveness of hand washing, the use of disks to evaluate antibiotics and household products, culturing normal body floras and floras in the environment, and demonstrations or exercises on fermentation, conjugation, DNA spooling, and person-to-person transmission of microbes. A number of exercises involving yeast (purchased in a supermarket) can be easily implemented in a classroom setting. Agar plates may be available from a microbiology course at the instructor's institution or from a hospital laboratory or may be purchased. Standard microbiology laboratory manuals, the *Journal of College Science Teaching* (published by the National Science Teachers Association), and *American Biology Teacher* (published by the National Association of Biology Teachers) are excellent sources of laboratory exercises that could be adapted to the classroom.

RESOURCES

The American Society for Microbiology maintains the MicrobeLibrary website (<http://www.microbelibrary.org>) with many resources for microbiology teaching and learning. You can find searchable visual and curriculum resource collections, the *Microbiology Education Journal*, the *Focus On Microbiology Education* newsletter, and a compilation of reviews of books, websites, videos, and software. The Department of Biological Sciences at Kent State University sponsors the Microbiology Learning Center (<http://dept.kent.edu/microbiology/default.htm>), which has an abundance of resources. The National Science Teachers Association and the National Association of Biology Teachers are also excellent sources. Lastly, I will be pleased to communicate with instructors about course content and structure and classroom (laboratory) demonstrations and exercises.

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