

Burton's MICROBIOLOGY FOR THE Health Sciences

ENHANCED ELEVENTH EDITION

40TH
Anniversary
Edition

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*Dedicated to our parents,
spouses, teachers, mentors, colleagues,
and friends who have encouraged and
helped us to fulfill our dreams.*

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During his career, Dr. Fader has taught microbiology in various capacities, including clinical laboratory science students, medical students, pathology residents, and infectious disease fellows. He has been honored with numerous teaching awards. He is also a past president of the Southwestern Association of Clinical Microbiologists.

Paul G. Engelkirk, PhD, MT(ASCP), SM(NRCM), is a retired professor of biological sciences from the Science Department at Central Texas College in Killeen, Texas, where he taught introductory medical microbiology for 12 years. Before joining Central Texas College, he was an associate professor at the University of Texas Health Science Center in Houston, Texas, where he taught diagnostic microbiology to medical laboratory science students for 8 years. Prior to his teaching career, Dr. Engelkirk served 22 years as an officer in the U.S. Army Medical Department, supervising various immunology, clinical pathology, and microbiology laboratories in Germany, Vietnam, and the United States. His last Army assignment was as Supervisor of Medical Microbiology research at Fitzsimons Army



Medical Center in Denver, Colorado. He retired from the Army with the rank of Lieutenant Colonel.

Dr. Engelkirk received his bachelor's degree in biology from New York University and his master's and doctoral degrees (both in microbiology and in public health) from Michigan State University. He received additional medical technology and tropical medicine training at Walter Reed Army Hospital in Washington, DC, and specialized training in anaerobic bacteriology, mycobacteriology, and virology at the Centers for Disease Control and Prevention in Atlanta, Georgia.

Dr. Engelkirk is an author of four microbiology textbooks, ten additional book chapters, five medical laboratory-oriented self-study courses, and many scientific articles. He also served for 14 years as coeditor of four separate newsletters for clinical microbiology laboratory personnel. Dr. Engelkirk has been engaged in various aspects of clinical microbiology for over 50 years and is a past president of the Rocky Mountain Branch of the American Society for Microbiology. He and his wife, Janet, currently provide biomedical educational services through their consulting business, Biomedical Educational Services (Biomed Ed), located in Round Rock, Texas. Dr. Engelkirk's hobbies include traveling, hiking, nature photography, writing, and observing nature from his back deck.

Janet Duben-Engelkirk, EdD, MT(ASCP), has over 40 years of experience in clinical laboratory science and higher education. She received her bachelor's degrees in biology and medical technology and her master's degree in technical education from the University of Akron. She obtained her doctorate in allied health education and administration from a combined program at the University of Houston and Baylor College of Medicine in Houston, Texas.

Dr. Duben-Engelkirk began her career in clinical laboratory science education teaching students "on the bench" in a medical center hospital in Akron, Ohio. She then became senior education coordinator and associate professor for the Clinical Laboratory Science Program at the University of Texas Health Science Center at Houston, where she taught clinical chemistry and related subjects for 12 years. In 1992, Dr. Duben-Engelkirk assumed the position of director of Allied Health and Clinical Laboratory Science Education at Scott and White Hospital in Temple, Texas, wherein her responsibilities included teaching microbiology and clinical chemistry. In 2006, Dr. Duben-Engelkirk assumed the position of chair of the Biotechnology Department at the Texas Bioscience Institute and Temple College, where

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Dr. Duben-Engelkirk was coeditor of a widely used clinical chemistry textbook and has coauthored three microbiology textbooks with Paul (clinical anaerobic bacteriology, laboratory diagnosis of infectious diseases, and this book). She has authored or coauthored numerous book chapters, journal articles, self-study courses, newsletters, and other educational materials over the course of her career.

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PREFACE

Microbiology—the study of microbes—is a fascinating subject that impacts our daily lives in numerous ways. Microbes live on us and in us and virtually everywhere around us. They are vital in many industries. Microbes are essential for the cycling and recycling of elements such as carbon, oxygen, and nitrogen, and provide most of the oxygen in our atmosphere. They are used to clean up toxic wastes. Microbes are used in genetic engineering and gene therapy. And, of course, many microbes cause disease. In recent years, the public has been bombarded with news reports about microbe-associated medical problems such as swine flu, bird flu, severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), hantavirus pulmonary syndrome, flesh-eating bacteria, mad cow disease, multidrug resistant bacteria, outbreaks of West Nile virus, chikungunya virus, Zika virus and Ebola virus, bioterrorism threats, food recalls as a result of *Escherichia coli* and *Salmonella* contamination, and epidemics of meningitis, hepatitis, influenza, tuberculosis, whooping cough, and diarrheal diseases.

WRITTEN FOR HEALTH CARE PROFESSIONALS

Burton's Microbiology for the Health Sciences has been written primarily for nurses and other health care professionals. This book provides students of these professions with vital microbiology information that will enable them to carry out their duties in an informed, safe, and efficient manner and protect themselves and their patients from infectious diseases. It is appropriate for use in any introductory microbiology course because it contains all of the concepts and topics recommended by the American Society for Microbiology for such courses. Unlike many of the lengthy introductory microbiology texts on the market, *all* of the material in this book can be covered in a typical undergraduate microbiology course.

Chapters of special importance to students of the health care professions include those dealing with disinfection and sterilization (Chapter 8); antibiotics and other antimicrobial agents (Chapter 9); epidemiology and public health (Chapter 11); health care-associated infections and infection control (Chapter 12); how infectious diseases

are diagnosed (Chapter 13); how microbes cause disease (Chapter 14); how our bodies protect us from pathogens and infectious diseases (Chapters 15 and 16); and the major viral, bacterial, fungal, and parasitic diseases of humans (Chapters 17 through 21).

NEW TO THE ENHANCED ELEVENTH EDITION

The *Enhanced Eleventh Edition* contains new information about the significance of the human microbiome on human health and development, an expanded coverage of health care-associated infections caused by multidrug resistant organisms, and the appearance of arboviruses such as chikungunya, dengue and Zika into the Americas. The book is divided into eight major sections, containing a total of 21 chapters. Each chapter contains a Chapter Outline, Learning Objectives, Self-Assessment Exercises, and information about the contents. Interesting historical information, in the form of “Historical Notes,” is spread throughout the book and is presented in appropriate chapters. More Critical Thinking questions have been added, and they are located on the online product.

STUDENT-FRIENDLY FEATURES

The authors have made every attempt to create a student-friendly book, which can be used by all types of students, including those with little or no science background and mature students returning to school after an absence of several years. It is written in a clear and concise manner. It contains more than 50 Study Aid boxes, which explain difficult concepts and similar-sounding terms. Key points are highlighted. New terms are defined in the text and are included in the Glossary at the back of the book.

Answers to Self-Assessment Exercises contained in the book can be found in Appendix A. Appendix B contains answers to the Case Study questions. Appendix C contains useful formulas for conversion of one type of unit to another (e.g., Fahrenheit to Celsius and vice versa). Because Greek letters are commonly used in microbiology, the Greek alphabet can be found in Appendix D.

ADDITIONAL RESOURCES

Burton's Microbiology for the Health Sciences, Enhanced Eleventh Edition, includes additional resources for both instructors and students that are available on the book's Navigate 2 Premier online site.

Instructor Resources

Approved adopting instructors will be given access to the following additional resources:

- Image Bank
- Test Bank
- Final Exam
- PowerPoint Slides
- Syllabus Conversion Guide
- Image Bank

Student Resources

Students who have purchased *Burton's Microbiology for the Health Sciences, Enhanced Eleventh Edition*, have access to the following additional resources, which are available on the Navigate 2 Premier online site:

- Animations covering various topics in the text
- TestPrep
- Online Study Guide
- Student Review Questions
- Appendix 1: Phyla and Medically Important Genera within the Domain Bacteria
- Appendix 2: Responsibilities of the Clinical Microbiology Laboratory

Purchasers of the text can access the resources online at the *Burton's Microbiology for the Health Sciences, Enhanced Eleventh Edition*, Navigate 2 Premier online site.

TO OUR READERS

As you will discover, the concise nature of this book makes each sentence significant. Thus, you will be intellectually challenged to learn each new concept as it is presented. It is our hope that you will enjoy your study of microbiology and be motivated to further explore this exciting field, especially as it relates to your occupation. Many students who have used this textbook in their introductory microbiology course have gone on to become infection control nurses, epidemiologists, medical laboratory professionals, and microbiologists.

OUR THANKS

We are deeply indebted to the late **Gwen Burton, PhD**—sole author of the first four editions of this book and co-author of the next four. Her spirit lives on in the pages of this, the *Enhanced Eleventh Edition*. We can only hope that she would be as proud of what her creation has become as we are. We are also grateful to all of those who helped with the editing and publication of this book, including Tim Rinehart, Editorial Coordinator; Jonathan Joyce, Acquisitions Editor; Shauna Kelley, Marketing Manager; Bridgett Dougherty, Production Project Manager; and Joan Wendt, Designer.

*Robert C. Fader
Paul G. Engelkirk
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User's Guide

In today's health careers, a thorough understanding of microbiology is more important than ever. *Burton's Microbiology for the Health Sciences, Enhanced Eleventh Edition*, not only provides the conceptual knowledge you will need but also teaches you how to apply it. This User's Guide introduces you to the features and tools of this innovative textbook. Each feature is specifically designed to enhance your learning experience, preparing you for a successful career as a health professional.

Chapter Opener Features

The features that open each chapter are an introduction to guide you through the remainder of the lesson.

Chapter Outline

Serves as a "roadmap" to the material ahead.

Learning Objectives

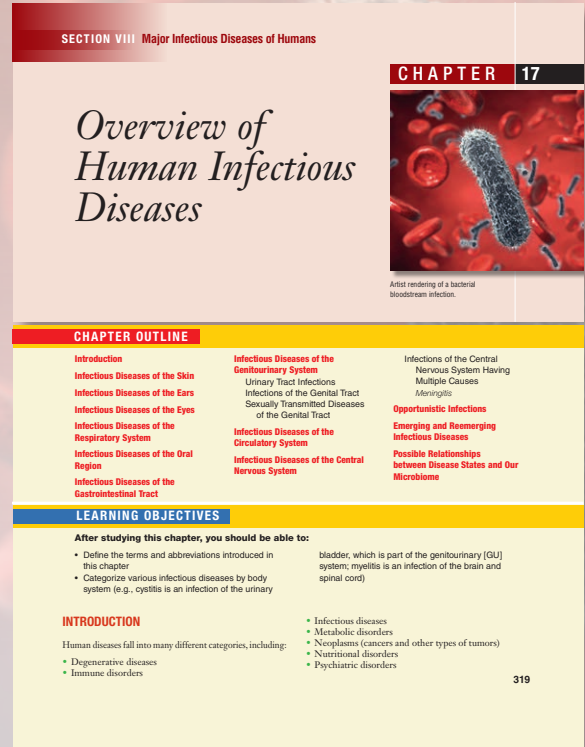
Highlight important concepts—helping you to organize and prioritize learning.

Introduction

Familiarizes you with the material covered in the chapter.

Chapter Features

The following features appear throughout the body of the chapter. They are designed to hone critical thinking skills and judgment, build clinical proficiency, and promote comprehension and retention of the material.



HISTORICAL NOTE

Culturing Bacteria in the Laboratory

The earliest successful attempts to culture microorganisms in a laboratory setting were made by Ferdinand Cohn (1872), Joseph Schroeter (1875), and Oscar Brefeld (1875). Robert Koch described his culture techniques in 1881. Initially, Koch used slices of boiled potatoes on which to culture bacteria, but he later developed both liquid and solid forms of artificial media. Gelatin was initially used as a solidifying agent in Koch's culture media, but in 1882, Fanny Hesse, the wife of Dr. Walther Hesse—one of Koch's assistants—suggested the use of agar. Frau Hesse (as she is most commonly called) had been using agar in her kitchen for many years as a solidifying agent in fruit and vegetable jellies. Another Koch's assistant, Richard Julius Petri, invented glass Petri dishes in 1887 for use as containers for solid culture media and bacterial cultures. The Petri dishes in use today are virtually unchanged from the original design, except that most of today's laboratories use plastic, presterilized, disposable Petri dishes. In 1878, Joseph Lister became the first person to

Historical Note Boxes

Provide insight into the history and development of microbiology and health care.



Spotlighting Boxes

These are a new feature spotlighting health care careers.



SPOTLIGHTING

Epidemiologists

Epidemiologists are scientists who specialize in the study of disease and injury patterns (incidence and distribution patterns) in populations and ways to prevent or control diseases and injuries. Epidemiologists study virtually all types of diseases, including heart, hereditary, communicable, and zoonotic diseases and cancer. In some ways, epidemiologists are like disease detectives, gathering and piecing together clues to determine what causes a particular disease, why it occurs only at certain times, and why certain people in a population get the disease whereas others do not. Quite often, epidemiologists are called on to track down the cause of epidemics and figure out how to stop them. Data collection and statistical analysis of data are among the many duties of epidemiologists.



STUDY AID

Bacterial Names Sometimes Provide a Clue to Their Shape

If “coccus” appears in the name of a bacterium, you automatically know the shape of the organism—spherical. Examples include genera such as *Enterococcus*, *Micrococcus*, *Peptostreptococcus*, *Staphylococcus*, and *Streptococcus*. However, not all cocci have “coccus” in their names (e.g., *Neisseria* spp.). If “bacillus” appears in the name of a bacterium, you automatically know the shape of the organism—rod-shaped or rectangular. Examples include genera such as *Actinobacillus*, *Bacillus*, *Lactobacillus*, and *Streptobacillus*. However, not all bacilli have “bacillus” in their names (e.g., *E. coli*).

Study Aid Boxes

Summarize key information, explain difficult concepts, and differentiate similar-sounding terms.



Something to Think About

These boxes contain information that will stimulate students to ponder interesting possibilities.



SOMETHING TO THINK ABOUT

“Initially hailed as ‘magic bullets,’ [antibiotics] are now used so often that success threatens their long-term utility. Unfortunately, the natural mutability of microbes enables pathogens to develop bullet-proof shields that make antibiotic treatments increasingly ineffective.

Our failure to adequately address resistance problems may ultimately push the control of infectious diseases back to the pre-penicillin era.” (From Drlica K, Perlin DS. *Antibiotic Resistance: Understanding and Responding to an Emerging Crisis*. Upper Saddle River, NJ: Pearson Education, Inc; 2011.)

Key Points

Help you pinpoint the main ideas of the text.

relationship is the termite and its intestinal protozoa. The protozoa digest the wood eaten by the termite, enabling both organisms to absorb the nutrients necessary for life. Without the intestinal protozoa, the termite would be unable to digest the wood that it eats and would starve to death. Symbiotic relationships are discussed in greater detail in Chapter 10.

Malaria, giardiasis, African sleeping sickness, and amebic dysentery are examples of human diseases caused by parasitic protozoa.

Self-Assessment Exercises

Help you gauge your understanding of what you have learned.



Self-Assessment Exercises

After studying this chapter, answer the following multiple-choice questions.

1. Which of the following individuals is considered to be the “Father of Microbiology?”
 - a. Anton van Leeuwenhoek
 - b. Louis Pasteur
 - c. Robert Koch
 - d. Rudolf Virchow
2. The microbes that usually live on or in a person are collectively referred to as:
 - a. germs
 - b. indigenous microbiota
 - c. nonpathogens
 - d. opportunistic pathogens

WEB RESOURCES

Visit the web resource to access the following resources:

- Animations
- Online Study Guide
- Student Review Questions

Web Resources Boxes

Direct you to additional content and exercises for review on the Navigate 2 Premier online site.

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