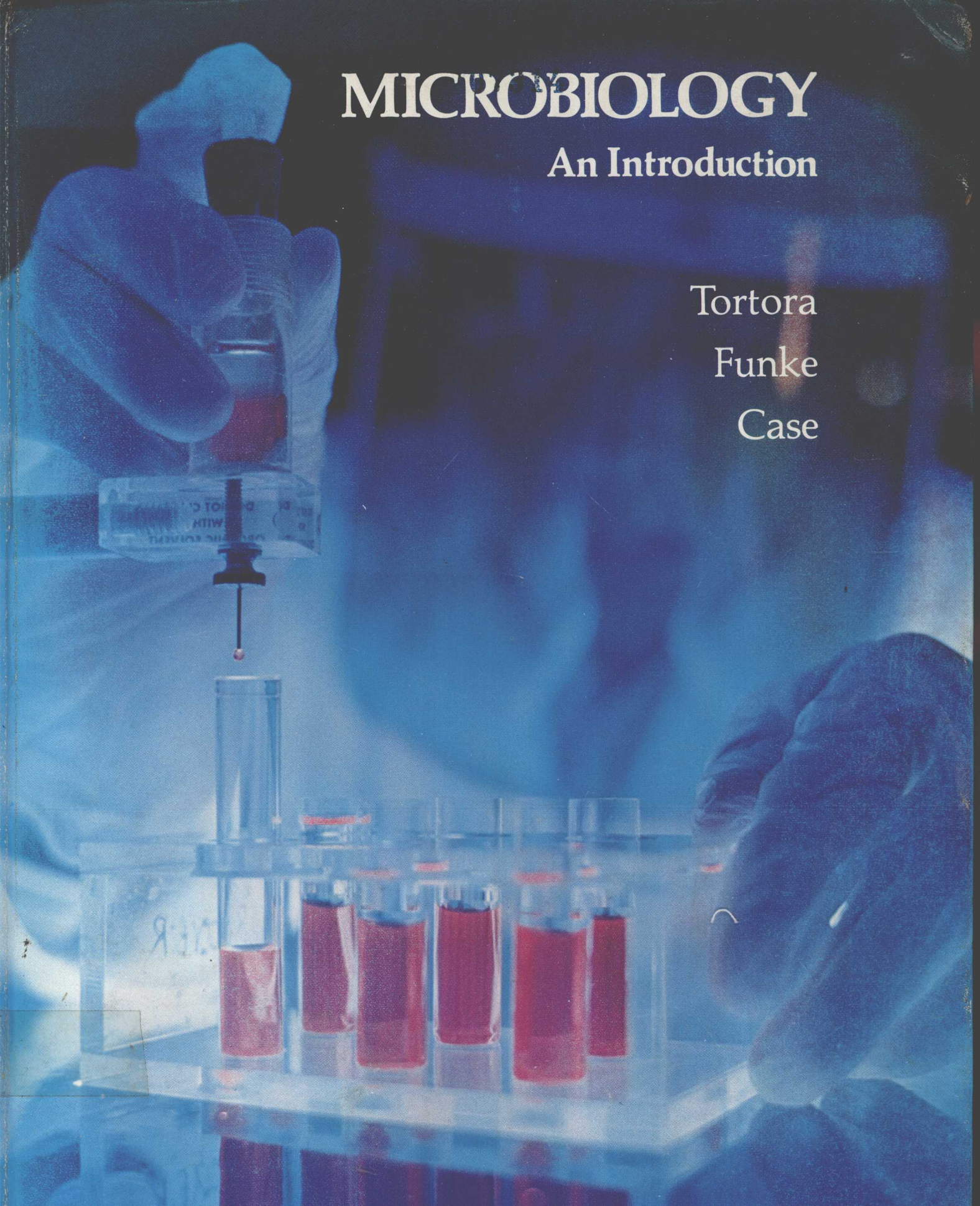
MICROBIOLOGY

An Introduction

Tortora
Funke
Case



MICROBIOLOGY

An Introduction

Gerard J. Tortora
Bergen Community College

Berdell R. Funke
North Dakota State University

Christine L. Case
Skyline College

The Benjamin/Cummings Publishing Company, Inc.
Menlo Park, California • Reading, Massachusetts
London • Amsterdam • Don Mills, Ontario • Sydney

Sponsoring Editor: James W. Behnke
Developmental Editor: Jane R. Gillen
Production Editor: Patricia S. Burner
Copy Editor: Janet Greenblatt
Book and Cover Designer: Michael A. Rogondino
Artist: Barbara Haynes
Illustrator: Michael Fornalski
Photo Researcher: Carl W. May

About the cover: A technician is isolating plasmids, which are tiny circles of DNA found in bacteria. The plasmids are dissolved in a dye solution that fluoresces pink under ultraviolet light. Genetic engineering using plasmids is revolutionizing the biological sciences and industry (see pages 226–229 and 704–707).

Figure acknowledgments begin on page 749.

Library of Congress Cataloging in Publication Data

Tortora, Gerard J.
Microbiology: an introduction.

Bibliography: p.
Includes index.
1. Microbiology. I. Funke, Berdell R.
II. Case, Christine L., 1948–
III. Title.
QR41.2.T67 576 81-21712
ISBN 0-8053-9310-2 AACR2

cdefghij-DO-89876543

The Benjamin/Cummings Publishing Company, Inc.
2727 Sand Hill Road
Menlo Park, California 94025

Preface

Microbiology: An Introduction is a comprehensive text for students in a wide variety of programs, including allied-health sciences, biological sciences, environmental studies, animal science, forestry, agriculture, home economics, and liberal arts. It is a beginning text, assuming no previous study of biology or chemistry.

OUR APPROACH: SUPPORTING PRINCIPLES WITH APPLICATIONS

In writing this text, we have tried to achieve an appropriate balance between microbiological fundamentals and applications, and between medical applications and other applied areas. We have provided the solid grounding in fundamental facts and principles necessary to understand and adapt to the rapid developments in microbiology. At the same time, we have integrated applications throughout the text because we know that beginning students benefit from seeing the relevance of microbiology to their respective programs. Since many students who will use this book are in allied-health fields, we have made the text especially comprehensive in medically important areas of microbiology. For example, the principles and applications of immunology have been particularly emphasized. We believe this emphasis is deserved in the light of the tremendous importance of immunology, both as a basic science and as the source of many new valuable tools and techniques for microbiology and the health sciences.

We have also provided an overview of microorganisms in nature and of applied microbiology outside the health sciences. Thus, we believe the text will be useful for students with quite varied interests. We hope that all students who use this text will gain an appreciation of the fascinating diversity of microbial life, the central roles of microorganisms in nature, and the importance of microorganisms in our daily lives.

We have made a special effort to prevent both fundamentals and applications from being as dull as these ponderous words sometimes imply. We have tried to present the material in a logical, readable, and enjoyable manner, giving special attention to the art and photo programs. The artwork has been carefully developed to complement the text exposition. There are more than 250 photographs, including a large number that have never before appeared in a text. We have chosen both state-of-the-art micrographs that dramatically show microbial structure and good examples of conventional micrographs that more closely resemble what is usually seen in a microbiology laboratory. Many of the photos were hand-picked from the Centers for Disease Control's photo files.

Many topics of contemporary concern, such as viruses and cancer, interferon, Legionnaires' disease, drug resistance, and recombinant DNA, are included in the body of the text. Specialized aspects of various timely topics are described in **special topic boxes** throughout the book. There are primarily two types of boxes: *Microbiology in the News* items and reprints from the Centers for Disease Control's *Morbidity and Mortality Weekly Report (MMWR)*. These boxes motivate students by relating microbiology to real-life issues and applications.

SCOPE AND SEQUENCE

The book is divided into five parts. Part I, *Fundamentals of Microbiology*, emphasizes bacteriology. It opens with an introductory chapter giving an historical perspective of microbiology and an overview of the microbial world. It is followed by a chapter providing the chemistry background necessary for understanding microbial activities. In the remainder of this part, the principles of microbial cell structure, metabolism, growth, and genetics are presented, as well as the more applied topics of microscopy, laboratory methods for growing microorganisms, the control of unwanted microbial growth (outside the human body), and genetic engineering.

Part II, *Survey of the Microbial World*, expands upon the distinctive characteristics of the important groups of bacteria, viruses, fungi, protozoans, and helminths. A concise but thorough treatment of medically important helminths is included because these organisms, although not strictly microorganisms, are important agents of human disease but often will not be encountered in another course. The chapter on fungi, protozoans, and helminths may easily be omitted or covered selectively.

The first two chapters of Part III, *Interaction of Microbe and Host*, are devoted to the relationships between microorganisms and humans and how such interactions can lead to disease. Host defenses are then discussed in the next three chapters. Reflecting the increasing importance of immunology today, considerable attention is given to kinds of immunity, characteristics of antigens and antibodies, antibody formation, serology, hypersensitivity, and immune responses to cancer. The last chapter in this part discusses another aspect of defense against harmful microbial invasion, antimicrobial drugs.

Part IV, *Microorganisms and Human Disease*, describes a number of commonly encountered microbial diseases. The various diseases are organized into chapters according to host organ system affected. Each chapter opens with a brief discussion of the functional anatomy of the human organ system and its normal flora, proceeds with separate sections covering bacterial, viral, fungal, protozoan, and helminthic diseases, and concludes with a summarizing table.

Part V, *Microbiology, the Environment, and Human Affairs*, discusses topics that are nonmedical but nonetheless vital to human health and well-being. The chapter on soil and water microbiology discusses the microorganisms that inhabit soil and water and their contributions to biogeochemical cycles, water pollution, and sewage treatment. The chapter on food and industrial microbiology covers food preservation, the traditional roles of microorganisms in food and chemical production, and the new industrial importance of microorganisms resulting from recombinant DNA research.

COURSE SEQUENCES

We have organized the book in what we feel is a useful fashion, but we recognize that there are a number of alternative sequences in which the material might be effectively presented. For those who wish to follow another sequence, we have made each chapter as independent as possible and have included numerous cross-references. Thus, the survey of the microbial world, Part II, could be studied at the beginning of a course, immediately after Chapter 1. Or environmental and industrial microbiology, Part V, could follow Parts I and II. Since Chapters 7 and 18 both deal with the control of microbial growth, they could be covered together. The material on microbes and human disease, Part IV, readily lends itself to rearrangement or selective coverage. The Instructor's Guide provides detailed guidelines for organizing the disease material in several alternative ways.

IN-TEXT LEARNING AIDS

A major goal of writing this text was to create a book that would be an effective tool for learning. Therefore, we have included many student aids in each chapter.

- **Objectives** provide students with guidelines for what they should know after studying the chapter.
- **Tables** summarize, organize, and complement the text discussions.

- **Study Outlines** at the end of each chapter aid review.
- **Study Questions** test recall of information presented in the chapter *(Review Questions)* and provide an opportunity to apply knowledge in problem-solving and interpretation *(Challenge Questions)*.
- **Further Reading** suggestions give sources for further investigation of the topics in the chapter.

Several **appendices** at the end of the book heighten its usefulness. The first appendix is the *Classification of Bacteria According to Bergey's Manual of Determinative Bacteriology, 8th edition*. This is followed by a guide to *Pronunciation of Scientific Names*, which provides basic rules of pronunciation and phonetic pronunciations of genus and species names used in the text. Also included is a guide to *Word Roots Used in Microbiology*, a *Most Probable Numbers Table*, and a brief description of *Methods for Taking Clinical Samples*. A **Glossary** provides definitions of all important terms used in the text.

SUPPLEMENTARY MATERIALS

- A **Study Guide**, by Berdell Funke, is available to help students master and review major concepts and facts from the text. Each chapter of the study guide begins with a chapter summary organized under the text headings. Important terms are printed in boldface and defined, and important figures and tables from the text are included. Following the summary is an extensive self-testing section containing matching questions, fill-in questions, and an answer key.
- An **Instructor's Guide**, by Christine Case, includes many practical suggestions for using the text in a course. *Suggested course outlines* are provided. For presentation of microbial diseases by microbial agent (taxonomic group), mode of transmission, or portal of entry, sequences of topics and pertinent pages are listed. Also included are the *answers to Study Questions*, in a format that can be used for grading, or reproduced and distributed to students for self-study. The final section of the Instructor's Guide is devoted to *test items;* each chapter has two objective tests, each containing 15 questions. The tests can be reproduced and used directly from the Guide.
- **Acetate overhead transparencies** of 50 two-color line drawings from the text are available from the Publisher upon written request.

ACKNOWLEDGMENTS

In the preparation of this textbook, we have benefited from the guidance and advice of a number of microbiology instructors across the country. Six contributors provided early drafts of chapters or portions of chapters. Twenty-eight reviewers offered constructive criticism and suggestions at various stages of manuscript preparation. We gratefully acknowledge our debt to these individuals.

Gerard J. Tortora
Berdell R. Funke
Christine L. Case

Contributors:

Richard Bernstein, San Francisco State University
Frank Binder, Marshall University
Cynthia Moffet, San Francisco
Roger Nichols, Weber State College
J. Dennis O'Malley, University of Arkansas
Leleng To, Hardin-Simmons University

Reviewers:

Barry Batzing, SUNY Cortland
Lois Beishir, Antelope Valley College
Harold Bendigkeit, De Anza College
L. J. Berry, University of Texas
Frank Binder, Marshall University
John Boyd, Napa College
Richard Davis, West Valley College
Norman Epps, University of Guelph
Cindy Erwin, San Francisco City College

Roger Furbee, Middlesex County College
James Garner, C. W. Post College
Ronald Hochede, City College of San Francisco
Robert Janssen, University of Arizona
Diana Kaftan, Diablo Valley College
Alan Konopka, Purdue University
Walter Koostra, University of Montana
John Lammert, Miami University of Ohio
John Lewis, San Bernardino Valley College
Peter Ludovici, University of Arizona
William Matthai, Tarrant County College
Roger Nichols, Weber State College
Elinor O'Brien, Boston College
J. Dennis O'Malley, University of Arkansas
Dennis Opheim, Texas A & M University
Violet Schirone, Suffolk County College
Louis Shainberg, Mount San Antonio College
Bernice Stewart, Prince Georges Community College
John Trela, University of Cincinnati

Brief Table of Contents

Detailed Table of Contents