

Preface

Microbiology is a dynamic science. It is constantly evolving as more information is added to the continuum of knowledge, and as microbiological techniques are rapidly modified and refined. The tenth edition of *Microbiology: A Laboratory Manual* continues to provide a blend of traditional methodologies with more contemporary procedures to meet the pedagogical needs of all students studying microbiology. As in previous editions, this laboratory manual provides a wide variety of critically selected and tested experiments suitable for undergraduate students in allied health programs, as well as elementary and advanced general microbiology courses.

Our Approach

This laboratory manual is designed to guide students in the development of manipulative skills and techniques essential for understanding the biochemical structure and function of a single cell. Its main goal is to encourage students to apply these laboratory skills in the vocational field of applied microbiology and allied health or to further pursue the study of life at the molecular level.

In this manual, comprehensive introductory material is given at the beginning of each major area of study, and specific explanations and detailed directions precede each experiment. This approach augments, enhances, and reinforces course lectures, enabling students to comprehend more readily the concepts and purposes of each experiment. This also provides a review aid if the laboratory and lecture sections are not taught concurrently. The manual should also reduce the time required for explanations at the beginning of each laboratory session and thus make more time available for performing the experiments. Finally, care has been taken to design experimental procedures so that the supplies, equipment, and instrumentation commonly found

in undergraduate institutions will suffice for their successful execution.

Organization

This manual consists of 75 experiments arranged into 16 parts. The experiments progress from those that are basic and introductory, requiring minimal manipulations, to those that are more complex, requiring more sophisticated skills. The format of each experiment is intended to facilitate presentation of the material by the instructor and to maximize the learning experience. To this end, each experiment is designed as follows:

Learning Objectives

This introductory section defines the specific principles and/or techniques to be mastered.

Principle

This is an in-depth discussion of the microbiological concept or technique and the specific experimental procedure.

Clinical Application

Clinical or medical applications that appear within each experiment help students connect what they are learning in lecture with what they are doing in the lab. For students who intend to have careers as nurses or in other allied health fields, Clinical Applications explain the relevance of each lab technique to their career plans.

At the Bench

This section signals the beginning of the experiment, and includes the materials, notes of caution, and procedural instructions—all of the things students will need to know at the bench, during the course of the experiment.

Materials

This comprehensive list helps students and instructors prepare for each laboratory session. Materials appear under one of the following headings:

Cultures These are the selected test organisms that have been chosen to demonstrate effectively the experimental principle or technique under study. The choice is also based on their ease of cultivation and maintenance in stock culture. A complete listing of the experimental cultures and prepared slides is presented in Appendix 6.

Media These are the specific media and their quantities per designated student group. Appendix 3 lists the composition and method of preparation of all the media used in this manual.

Reagents These include biological stains as well as test reagents. The chemical composition and preparation of the reagents are presented in Appendices 4 and 5.

Equipment Listed under this heading are the supplies and instrumentation that are needed during the laboratory session. The suggested equipment was selected to minimize expense while reflecting current laboratory technique.

Procedure

This section provides explicit instructions, augmented by diagrams, that aid in the execution and interpretation of the experiment.

 A caution icon has been placed in experiments that may use **potentially pathogenic materials**. The instructor may wish to perform some of these experiments as demonstrations.

Lab Report

These tear-out sheets, located at the end of each experiment, facilitate interpretation of data and subsequent review by the instructor. The *Observations and Results* portion of the report provides tables for recording observations and results, and helps the students draw conclusions from and interpret their data. The *Review Questions* aid the instructor in determining the student's ability to understand the experimental concepts and techniques. Questions that call for more critical thinking are indicated by the light bulb icon.



New to the Tenth Edition

For this tenth edition, the primary aim was to build upon and enrich the student experience. The changes described below are intended to impart the relevance of microbiological lab techniques to student career goals, and to enhance student understanding and performance of each of the microbiological procedures.

New Clinical Applications

The tenth edition includes new Clinical Applications added to each experiment that help students understand why they're learning individual techniques and connect the lab and lecture to students' future careers as nurses and in other allied health fields. With topics that vary from diagnosing lung infections to selection of effective antibiotics and beyond, clinical applications make the experiments come alive to students.

New Experiment 1: Effectiveness of Hand Washing

This experiment reinforces the importance of appropriate hand washing and introduces students to microbiology in a fun, easy way. By understanding that microorganisms thrive on their hands, students are also shown the importance of aseptic techniques, both to protect their health and preserve the value of the experiments they are performing.

New Quiz Questions in Mastering Microbiology®

Each experiment in the tenth edition is now accompanied by assignable, automatically graded quiz questions in MasteringMicrobiology®. Each Experiment includes 10 quiz questions correlated to the lab manual Learning Objectives for fast, convenient tracking of course outcomes in the MasteringMicrobiology gradebook.

Additional Protozoa, Fungi, and Yeast Photos Added

Based on reviewer requests, the tenth edition now includes nine new full-color photos and micrographs of protozoa, fungi, and yeast that can be found in Parts 6 and 7 of the manual.

New "Additional Readings" in the Instructor Guide

Additional reading research articles for each experiment have been added to the Instructor Guide. Articles are relevant to the experiment being performed and are ideal recommendations for further exploration.

Updates and Revisions

Throughout the manual, updates and revisions have been made to background information, terminology, equipment, and procedural techniques, including the following:

- Added a new procedure and photo for the slide method of the catalase test in Experiment 30.
- Added a new procedure for the filter paper method of the oxidase test in Experiment 31.
- New Observations and Results table in the Lab Report for Experiment 32 covers all experimental organisms.
- Updated photos of *Plasmodium vivax*, *Trypanosoma gambiense*, and *Giardia intestinalis* in Experiment 35.
- Added a new photo showing the minimum inhibitory concentration tube set-up in Experiment 45.
- Updated photo of the development of colonies on a membrane filter plate in Experiment 50.
- Figure 58.3 was altered to agree more precisely with the experimental bacterial transformation procedure.
- Deleted the Agglutination Reaction: Mono-Test for Infectious Mononucleosis from the ninth edition in order to make room for the new hand-washing experiment.

Instructor Resources

The *Instructor Guide* (ISBN 0-321-86365-8) is a valuable teaching aid for instructors. It has been updated to reflect changes in the main text, and provides the following:

- Laboratory safety protocol for the instructional staff
- Laboratory safety protocol for the technical staff
- New Additional Reading research articles for each experiment

- For each experiment: detailed lists of required materials, procedural points to emphasize, suggestions for optional procedural additions or modifications, helpful tips for preparing or implementing each experiment, and answers to the Review Questions in the student manual
- Appendices with the formulas for the preparation of all media, test reagents, and microbiological stains, as well as the microorganisms required for the performance of each procedure

Acknowledgments

I wish to express my sincere gratitude to the following instructors for their reviews of the tenth edition. Their comments and direction contributed greatly to the tenth edition.

Cynthia Anderson, Mt. San Antonio College
M. Kristie Bompadre, Alvernia University
Deborah Britt, Rhode Island College and Brown University
Orianna Carter, Ohio University Southern
Woo-Suk Chang, University of Texas at Arlington
Tanya Crider, East Mississippi Community College
Donald Deters, Bowling Green State University
Srinivasan Durairaj, MacMurray College
Sherie Edenborn, Chatham University
Ralph Fleming, Burlington County College
Eric Ford, East Mississippi Community College
Julie Harless, Lone Star College-Montgomery
Robin R. Hayes, Hartnell College
Parmmeet Jodhka, Tarrant County College, Northwest Campus
Fred Krick, Des Moines Area Community College
Jane McLaughlin, Orange Coast College
Oluwatoyin Osunsanya, Muskingum University
Adam Parks, Shepherd University
Diane Pelletier, Green River Community College
Stacy Pfluger, Angelina College
Nahed Salama, SUNY Rockland Community College
George Shiflet, Wofford College
Amy Sprenkle, Salem State University
Douglas Stemke, University of Indianapolis
Chad Welsh, Lindenwood University

I would like to express my sincere gratitude to Dr. Chad Welsh at Lindenwood University and Dr. James Yount at Brevard Community College for reviewing, editing, and writing Clinical Applications for the new edition. Their help made this exciting new feature even stronger. Thanks also to Dr. Welsh for providing the Additional Readings for the Instructor Guide. I am grateful for the work of Dr. Brent Sellinger at the University of Lethbridge. His fine photography and expert experimental setup will be valuable learning tools for students for many years to come.

I wish to extend my appreciation to the staff at Pearson Education, whose expertise and technical skills have guided me over many years. Marie Beaugureau, project editor, provided

invaluable direction in this new edition; her dedication to the highest standards has left its mark on every page of the manual. In addition, I would like to thank Kelsey Churchman, acquisitions editor, Megan Power, production coordinator, and Cheryl Wilson, project manager. I also wish to express my gratitude to the microbiology laboratory technicians at SUNY Rockland Community College—Ms. Joan Grace, who early on performed all the experiments to ensure their success when repeated by the students, and Ms. Roz Wehrman, who followed in Joan's footsteps. Last, but certainly not least, I would like to acknowledge Ms. Allyson Cerreon for her assistance with the hand washing experiment.

James G. Cappuccino