

Preface

Perspectives on Microbiology

It has been nearly ten years since the first edition of this text was published, a decade marked by extensive discoveries and developments related to the science of microbiology. In fact, the total amount of information on this subject has doubled and possibly tripled during this relatively short time. Dealing with such an abundance of new information has, at times, been overwhelming. But this degree of enrichment has only served to reinforce the far-reaching importance of the subject matter. One has only to pick up a newspaper to be struck by daily reminders of microbiology's impact, whether it be emerging diseases, the roles of viruses in cancer, the development of new vaccines, drugs, and bioengineered organisms, or the use of microbes to clean up toxic wastes. Thanks to technologies that really originated with microbiologists, we now have detailed genetic maps of hundreds of microbes, plants, and animals, including humans. These discoveries, in turn, have spawned entirely new sciences and applications and an explosion of new discoveries. So, as we look back over these few years, one idea that rings even truer than ever is an observation made about 120 years ago by the renowned microbiologist Louis Pasteur:

"Life would not long remain possible in the absence of microbes."

Looking ahead to the future, microbiology will continue to dominate biology, medicine, ecology, and industry for many years to come. Clearly, the more you learn about this subject, the better prepared you will be for personal and professional challenges, and to make decisions as a citizen of the world.

Emphasis of *Foundations in Microbiology*

The primary goals of this textbook are to:

- involve you in the relevance and excitement of microbiology.
- help you understand and appreciate the natural roles, structure, and functions of microorganisms.
- continue building your knowledge and facilitating your ability to apply the subject matter.
- encourage skills that make you a lifelong learner in the subject.

Microbiology is an inherently valuable and useful discipline that offers an intimate view of an invisible world. We have often felt that certain areas of the subject should be taught at the high school, junior high, and even elementary levels, so that knowledge of microbes and their importance becomes second nature from an early age. The orientation of this textbook continues to be a presentation that is understandable to students of diverse backgrounds. We hope to promote interest in this fascinating subject, and to share our sense of excitement and awe for it. We hope our involvement in the subject, our love of language, and our fun with analogies, models, and figures are so contagious that they stimulate your interest and catch your imagination.

Like all technical subjects, microbiology contains a wide array of facts and ideas that will become part of your growing body of knowledge. One of the ways to fulfill the goals of the textbook is to concentrate on understanding concepts—important, fundamental themes that form a framework for ideas and words. Most of these concepts are laid out like links in a chain of information, each leading you to the next level. As you continue to progress through the book, you can branch out into new areas, refine your knowledge, make important connections, and develop sophistication with the subject. Most chapters are structured with two levels of coverage—a general one that provides an overall big picture, and a more specific one that fills in the details of the topics.

The order and style of our presentation are similar to those of the previous edition, but as in past editions, we have included extensive revisions. We realize that many courses do not have extra time to cover every possible topic, and so we embarked on this edition with the goals of updating and simplifying content where necessary or possible, improving illustrations, streamlining and balancing the coverage, and editing for currency, accuracy, and clarity. We extensively updated figures and statistics, and introduced pertinent events and major discoveries of the past three years. We have added approximately 20 new figures and 50 new photographs, and have revised about half of the figures. Although the basic book plan is similar to that of the last edition, it has been redesigned with a new color scheme, chapter opening page, table structure, and boxed reading organization.

Despite the amount of new information being generated every year, we have aimed to cover both traditional and new developments in microbiology without adding to the length of the book. We have streamlined the disease chapters by removing

some material on diagnosis and laboratory tests, and we have balanced the first chapter to emphasize the highly beneficial nature of microbes. In addition, we have added a series of “overview” statements at the opening of each chapter. These statements replace the outline, which is still available in the contents section. The chapter capsules have been converted to an outline format, with more concise summaries, and new questions have been added to most chapters.

A Note to Students

This book has been selected as part of a course that will prepare you for a career in the health or natural sciences. The information it contains is highly technical and provides a foundation for the practical, hands-on work and critical thinking that are an integral part of many science-based professions. You will need to understand concepts such as cell structure, physiology, disinfection, drug actions, genetics, pathogenesis, transmission of diseases, and immunology, just to name a few. Like all science courses, this type of course will require prior preparation, background, and significant time for study. You will need to develop a working knowledge of terminology and definitions, and learn the “how and why” of many phenomena. Like all learning, the study of microbiology can be a lifelong discovery experience that makes you a well-informed person who can differentiate fact from fiction and make well-reasoned interpretations and decisions.

FACTS ABOUT LEARNING STYLES

We assimilate information in several ways, including visual, auditory, or some combination of these. According to William Glasser, the retention of information can be quantified as follows:

We remember about

- 10% of what we read,
- 20% of what we hear,
- 30% of what we see,
- 50% of what we see and hear,
- 70% of what is discussed with others,
- 80% of what we experience personally,
- 95% of what we teach to someone else.

With this background in mind, what are some of the ways you can maximize your learning? First, you will want to develop consistent study habits, preferably having some contact with the material every day. Many students highlight key portions in a chapter as they read, but such passive activity may use up valuable time and energy without involving your emotions. You will retain far more information if you engage your mind with the words and ideas. This might include writing marginal notes to yourself, questioning yourself on understanding, and outlining only the most significant points as you read.

Another strategy for active learning is to write questions and answers on index cards to use as a portable review and self-quiz. The benefits of this are twofold: first, it uses muscular activity (writing) and second, it requires you to think about the material.

Making models is another valuable technique for setting down memories. This could include making “mental maps” or flow diagrams of how various ideas interrelate, or the order of steps in a process.

Since the highest levels of learning occur within a group setting, it is highly desirable to collaborate in study groups or with a tutor. Be aware that teaching uses all of the sensory and motor parts of the brain, which is why it is the most effective pathway to learning. In the group setting, you can take the role of a teacher by asking questions, explaining ideas, giving definitions, and drawing diagrams.

Another factor that contributes to successful study is the realization that the brain is not a tireless sponge that can “soak up” information without rest. We now know that a chemical messenger in the part of the brain that regulates memory must be regenerated about every 30–45 minutes. Any information studied when the messenger is inactive will not be placed into memory. This explains why trying to “cram” a lot of information in a long marathon of studying is relatively ineffective. The best learning takes place in short bursts with frequent breaks. Even if you have to study over a longer stretch, you should relax for a few moments, take a walk, or involve your mind in some activity that doesn’t require intense thought. Spending an hour every day with flash cards is a far more effective way of learning than trying to absorb three chapters of material in a single marathon session.

RESOURCES

The text features several resources to help you in your studies.

Vocabulary, Glossary, and Index

The study of microbiology will immerse you in a rich source of terminology. No one expects the beginner to learn all of these new terms immediately, but an enhanced vocabulary will certainly be essential to understand, speak, and write this new language. To assist you in building vocabulary, the principal terms appear in boldface or italics and are defined or used in context. For terms marked by an asterisk, pronunciation and derivation information is given in a footnote at the bottom of the page. As a rule, speaking a word will help you spell it, and learning its origin will help you understand its meanings and those of related words.

The glossary is expanded in this edition to include definitions of all the boldface and italicized terms used in the text. The index is also detailed enough to serve as a rapid locator of terms and subject matter.

Chapter Checkpoints and Chapter Capsules with Key Terms

Sometimes the amount of factual information in a chapter can make it difficult to see the “forest for the trees.” A beneficial strategy at such times is to pause and review important points before continuing to the next topic. Throughout each chapter, we have included three to six brief summaries called *Chapter Checkpoints* that concisely state the most important ideas under a major heading, and provide you with a quick recap of what has been covered

to that point. Many instructors assign these as a guide for study and review.

At the end of each chapter, the major content of the chapter is condensed into short summaries called *Chapter Capsules with Key Terms*. These summaries take the form of an outline, with key terms placed in context with their associated topics. Capsules can be used as both a quick review and preview of the chapter.

The subject matter in this text is basic, but that doesn't mean it is simple, or that it is merely a review of information you have had in a prior biology course. Microbiology is, after all, a specialized area of biology with its own orientation and emphasis. There is more information presented here than can be covered in a single course, so be guided by your instructor's reading assignments and study guide.

Question Section

Each chapter concludes with an extensive question section intended to guide and supplement your study and self-testing. The number and types of questions are diverse so that your instructor can assign questions for desired focus and emphasis. Due to space constraints, the text contains answers only to multiple-choice and selected matching questions (see appendix E). The *multiple-choice* type of objective question is commonly used in class testing and standardized exams, and is a quick way to assess your grasp of chapter content. *Matching* questions have a list of words and a list of numbered descriptions that are meant to correlate. The *concept* questions direct you to review the chapter by composing complete answers that cover essential topics and use correct terminology. *Critical-thinking* questions challenge you to use scientific thinking, analysis, and problem solving. They require that you find relationships, suggest plausible explanations, and apply these concepts to real-world situations. By their nature, most of these questions allow more than one interpretation and do not have a predetermined, "correct" answer.

FINAL NOTE OF ENCOURAGEMENT

One of life's little truths is that you get out of any endeavor what you put into it. Therefore, the more time you spend in serious study, the more you will learn. This will lead to a pride in mastery, greater skill in discovery, and the thrill of learning that is almost like being a microbiological detective!

Acknowledgments

A textbook is a collaboration that takes on a life of its own. No single person can take full credit for its final form. The one thing that we all agree upon, whether author, reviewer, or editor, is that we want it to be the best possible microbiology book we can create. The authors have been fortunate to have an exceptional editing and production team from McGraw-Hill for this edition. The person most responsible for keeping us on track and focused on our goals is Jean Sims Fornango, our Developmental Editor. Her contributions run the gamut from careful synopsis of the book

pedagogy and detailed proofreading, to soothing our concerns and twisting our arms. She meets every challenge with good humor, insight, and professionalism, and we feel truly fortunate to have been in her capable hands. We also value our relationship with our publisher, James M. Smith, for his can-do attitude and support for meaningful and long overdue additions and improvements to the book. We also enjoyed collaborating with the able production team, including Rose Koos, Lori Hancock, Wayne Harms, and Connie Mueller.

Valuable support has also come from reviewers who shared their expertise in several specialized areas of microbiology. We would like to express sincere appreciation to Robert White, Lundy Pentz, Harry Kesler, Leland Pierson, Hugh Pross, and Valeria Howard for their detailed analyses of the chapters on chemistry, metabolism, genetics, drug therapy, and immunology. Many thanks also to Louis Giacinti, Jackie Butler, and Joseph Jaworski for their valued contributions and suggestions for improving several chapters. We would like to thank our many student readers and instructors from around the country for their kind and informative e-mails. You are the unsung heroes of textbook publishing.

We value the support and feedback from colleagues and students at Pasadena City College. In particular, we would like to recognize Barry Chess, a good friend and a talented microbiologist who can navigate his students through the most challenging areas of the subject with ease and humor; and Terry Pavlovitch, an able and creative biologist, who shares her love of teaching with us. We also owe a debt of gratitude to Mary Timmer, our proficient lab technician, whose attendance to the demands of a very busy microbiology laboratory have freed us to devote time to writing and conceptualizing illustrations. Over the past 30 years, countless fine students here at Pasadena City College have literally served as the "test lab" for shaping and refining the content of the book. It has been a wonderful side effect of teaching microbiology to watch our students grow and become friends and associates. Abigail Bernstein deserves special mention. She has been by Kathy's side as a tutor, lab assistant, and friend, and is a budding microbiologist. Abigail has the difficult job of being the "front" woman who works tirelessly answering questions and helping students use the book.

It takes about a year and a half to complete a textbook revision, during which time the manuscript is edited, reedited, and then edited again. All alterations are carefully spell-checked and proofread by the author, editors, and a number of others from the production staff. The figures are scrutinized for accuracy in labeling and composition. Unfortunately, even in these days of computerized cross-checks, some errors can still slip through. We appreciate knowing about errors you detect or critiques you may have regarding text content, figures, and boxed material, and encourage you to share any ideas you have for changes and improvements. We can be reached through the McGraw-Hill Company (www.mcgraw-hill.com) or by e-mail at ktalaro@aol.com.

We have enjoyed a superb team of reviewers for the fourth edition who were both formative and informative members of the team. They have been a significant source of suggestions about content, order, depth, organization, and readability. So, too, have

they lent their microscopic precision for screening the accuracy and soundness of the science. They have been there for us for nearly 18 years, keeping us on our toes and contributing in hundreds of ways to this ongoing project. We couldn't do it without them.

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