third edition

FOUNDATIONS IN

WICKOBIOLOGY Basic Principles

Kathleen Park Talaro Arthur Talaro R937E-37



third edition

FOUNDATIONS IN

MICROBIOLOGY

Basic Principles



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FOUNDATIONS IN MICROBIOLOGY BASIC PRINCIPLES THIRD EDITION

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TARLE I

PROVISIONAL CASES OF SELECTED NOTIFIABLE DISEASES (UNITED STATES, WEEK ENDING JANUARY 3, 1998)

Source: Data from Morbidity and Mortality Weekly Report, Vol. 46, nos. 52 and 53 (January 9, 1998).

N: Not notifiable U: Unavailable —: no reported cases C.N.M.I.: Commonwealth of Northern Mariana Islands

^{*}Updated monthly to the Division of HIV/AIDS Prevention—Surveillance, and Epidemiology, National Center for HIV, STD, and TB Prevention, last update December 23, 1997.

[†]National Electronic Telecommunications System for Surveillance.

 $[\]ensuremath{^\S{P}}\xspace$ Public Health Laboratory Information System.

TABLE II

PROVISIONAL CASES OF SELECTED NOTIFIABLE DISEASES PREVENTABLE BY VACCINATION (United States, WEEK ENDING JANUARY 3, 1998)

() ×	H. influ- enzae,	Hepatitis (Viral), by type		Measles (Rubeola)			Menin- gococcal			
invasive	Α	В	Indigenous	Imported [†]	Total	Disease	Mumps	Pertussis	Rubella	
Reporting Area	Cum. 1997*	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997
UNITED STATES	1,056	27,799	8,749	78	57	135	3,117	612	5,519	161
NEW ENGLAND Maine	65 5	632 66	153 6	11	8	19 1	205 18	12	990 11	2
N.H.	12	35	18	1		1	18	1	143	_
Vt.	3	15	10	10	_		4	_	262	_
Mass. R.I.	40	241 130	56 18	10	6	16	102 21	4	522 17	1
Conn.	2	145	45		1	1	42	1	35	1
MID. ATLANTIC	147	1,917	1,315	19	8	27	325	59	409	32
Upstate N.Y. N.Y. City	41 35	373 705	331 434	2 9	3 2	5 11	75 46	13	161 62	5 27
N.J.	51	287	222	3		3	73	7	11	_
Pa.	20	552	328	5	3	8	131	36	175	_
E.N. CENTRAL Ohio	161 86	2,858 332	916 94	6	3	9	461 164	80 35	544 165	5
Ind.	19	322	93		_	_	58	14	85	_
Ill. Mich.	38 15	706 1,342	227 456	6	1 2	7 2	148 53	13 15	126 62	2
Wis.	3	156	46		_	_	38	3	106	3
W.N. CENTRAL	65	2,201	472	13	5	18	235	18	599	2
Minn. Iowa	44 7	196 492	44 47	3	5	8	34 48	6 10	384 113	_
Mo.	10	1,109	326	î	_	1	109		68	2
N. Dak. S. Dak.		11 27	5 1		_	8	2	-	2 5	
Nebr.	1	109	16		_	_	14	2	14	_
Kans.	1	257	33			_	22		13	
S. ATLANTIC Del.	174	2,154 31	1,302	2	15	17	558 5	85	438	83
Md.	58	215	195		2	2	42	10	125	
D.C. Va.	13	36 233	30 128	_	3	3	9 58	19	3 56	1
W. Va.	4	12	16				18		6	1
N.C.	21	211	265		2	2	97	12	118	59
S.C. Ga.	4 42	110 657	98 148		1	1	61 106	11 10	30 14	19
Fla.	32	649	416	2	5	* ¹ / ₇	162	23	85	3
E.S. CENTRAL	48	637	692	351	-	_	237	28	144	_
Ky. Tenn.	6 27	76 402	40 449		_	_	48 85	3 7	61 40	_
Ala.	15	90	80		_		85	9	35	_
Miss.		69	123		_		19	9	8	_
W.S. CENTRAL Ark.	54 1	5,515 221	1,188 63	3	5	8	282 34	75 1	296 60	4
La.	14	239	171	_	_	_	48	16	20	_
Okla. Tex.	34 5	1,424 3,631	52 902	3	1 4	1 7	45 155	58	49 167	4
MOUNTAIN	99	4,369	898	6	2	8	190	59	1,252	6
Mont.		72	12	-	-	_	9	_	19	
Idaho Wyo.	1 4	150 41	54 40		_	_	15 4	6	570 7	- 1
Colo.	21	407	154	-	-		51	3	348	-
N. Mex. Ariz.	10 36	359 2,376	263 206	5	_	5	30 46	N 34	198 45	5
Utah	3	547	92	-	1	1	16	8	26	_
Nev.	24	417	77	1	1	2	19	7	39	_
PACIFIC Wash.	243	7,516 673	1,813 80	18 1	11 1	29 2	624 92	196 21	847 406	27 5
Oreg.	. 35	378	109	1	-	_	126	N	10	_
Calif. Alaska	188	6,296 34	1,592 21	15	8	23	396	147 4	403 14	14
Hawaii	7	135	11	2	2	4	7	24	14	8
Guam		_	3	-	_	-	1	1	_	_
P.R. V.I.	_	257	1,376	_	_	_	10	7	2	_
Amer. Samoa	_	_	_	_	-	_	_	_	_	
C.N.M.I.	6	1	34	1	_	1	_	4	_	-

Source: Data from *Morbidity and Mortality Weekly Report*, Vol. 46, nos. 52 and 53 (January 9, 1998).

N: Not notifiable —: no reported cases C.N.M.I.: Commonwealth of Northern Mariana Islands

^{*}Of 242 cases among children aged < 5 years, serotype was reported for 126 and of those, 47 were type b.

[†]For imported measles, cases include only those resulting from importation from other countries 11 g 100 k. COM

We dedicate this edition to our parents, Donald and Grace Park of Blackfoot, Idaho, and Arsenio and Florentina Talaro of Honokaa, Hawaii, and acknowledge them for the gifts they gave us. By nurture and example, they taught us the love of knowledge, the benefits of meaningful work, and the joys of creativity and curiosity. Though our fathers are no longer with us, our memories of them are still a daily source of encouragement and inspiration.

PREFACE

Microbiology for the Millennium and Beyond

In the three short years since the previous edition of this book was published, events have continued to validate the importance and impact of microorganisms. As we reflect on the recent past and enter the twenty-first century, we appear to be teetering on the brink of what promises to be the "era of microbiology." The science is growing at an astounding rate, and it continues to branch out into new realms. Discoveries keep coming to light that dazzle even seasoned microbiologists. We now know that complex microbial communities living deep in the earth's crust probably outnumber those on the earth's surface and are intimately involved in the geologic processes of the earth. Who would have expected that an insidious type of protein (prion) could be transmitted as an infectious agent and cause serious problems for agriculture and food handling? We watch from the sidelines in surprise and alarm at reports that biological warfare agents such as anthrax are being amassed as instruments of death. And more than ever before, we are made aware (sometimes uncomfortably) of the microbial contents of the food we eat, the water we drink, and even the air we breathe. For the past twenty years, the central role of microorganisms has continued to dominate strides in molecular biology and genetic engineering, and it influences most of the new technologies in industry. As Dr. Samuel Kaplan, chairman of the Department of Microbiology and Molecular Genetics at the University of Texas Medical School, said:

The science of microbiology is alive and well; it flourishes because of the intrinsic wealth of its subject matter. Its study has spawned the Human Genome Project, plant molecular biology, neurobiology, and all of the rest.

Even a casual observer would have to admit that becoming knowledgeable about microorganisms is no longer a convenience; it is a necessity, regardless of what your future holds. Studying microbiology will add immensely to your personal development, to your future career, and to your ability to make informed, perceptive decisions about the momentous new era of technology. Clearly, the more you learn about the subject of microbiology, the more you will understand about yourself and the world you live in.

Mission and Organization of the Textbook

The driving force of this textbook has always been to provide students with a solid background in the science of microbiology that prepares the student for future coursework and practical applications. As do all technical subjects, microbiology contains a wide array of facts and ideas to be incorporated into your growing store of knowledge. One of the ways to remain grounded in the subject is to concentrate on understanding concepts—important fundamental ideas or themes that explain a process or form a framework for ideas and words. Most of these concepts are laid out like links in a chain of information that lead 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: one that can be used to learn general concepts and one that encourages learning of specific ideas.

The order and style of our presentation are similar to those in the previous edition, but we have incorporated extensive changes. Our primary goals with this edition were to update, simplify, and improve illustrations. Although changes in written text are difficult to detect by a cursory look, every sentence has been carefully evaluated for currency, accuracy, and clarity. We have extensively updated figures and statistics and have introduced pertinent events and discoveries occurring since 1996. We have added about 10 new figures and 30 new photographs and have revised 200 figures. Although the basic design is intact, the use of color in tables and boxes has been altered to improve their readability, and the formats for chapter openers have a new look.

Despite an overwhelming amount of new information being generated every year, we have aimed to present a balanced coverage of traditional and new developments in microbiology without adding to the length of coverage.

Major Areas of Change

We have emphasized the changes in taxonomy that have resulted from ribosomal RNA analysis, and we have updated information on emerging diseases. The presentation of media has been altered, and new photographs have replaced older illustrations on staining techniques. We have added a new illustrated table on bacterial shapes and arrangements, have supplemented information on molecular techniques in identification, and have added an expanded section on the archaea. Tables and figures in the virus chapter have been revised for simplicity. Major changes in the presentation of metabolism and genetics include new and revamped figures, refinements in tables, and fine-tuning of the text to fit figures. Several examples used for biotechnology have been updated, including a box on the Human Genome Project and use of mitochondrial DNA. Improvements have been made to figures in microbial control, including a new box on antibacterial products, new material on the use of UV radiation, and updated information on drugs and drug resistance. To reflect the changing scope of immunology, we have modified coverage on cytokines and have added a flowchart to summarize host defenses. Introduction of new vaccines and vaccine development are significant additions. The coverage of specific diseases has been researched for accuracy, and certain chapters have been retitled for clarity. Chapters 18 through 25 have been supplemented with the latest information on new bacteria, viruses, and parasites. We have also moved the actinomycetes from the fungus chapter to the gram-positive bacteria chapter. The section on AIDS has been amended to include new information on virus structure, infection, drugs, and vaccines. Improvements have been made to the coverage of photosynthesis and some elements of food microbiology. We have added more questions to most chapters and a section suggesting Internet search topics.

The heart and soul of this book join to promote interest in this fascinating subject and to share some of our sense of excitement and awe for it. We hope that 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 get you caught up in "microfever."

Features of the Third Edition

CHAPTER OUTLINE AND CONTENT

We have retained most elements of the original format from the previous editions. The Brief Contents provides chapter titles and order. Detailed chapter headings, with page numbers are given in the Contents and appear again at the beginning of each chapter.

Organization and Learning Tools

The master plan for chapter organization is as follows:

Opening Page

Every chapter begins with a brief opening statement or description followed by an outline of major chapter headings with page references. Framed in the center is a visual image that focuses attention on an interesting snippet related to the chapter.

Headings

The chapter is organized into sections by means of headings. Primary and secondary headings appear in large type and introduce general sections with a word or description. Lower level headings lead into subsections and help to partition general topics into smaller, more specific areas of discussion.

Illustration and Photography Program

Written text, especially that of a complex nature, is greatly enhanced by illustrations and photographs. A concrete visual image can help the reader picture abstract processes and ideas, and it can make even the most routine concept memorable. In addition to hand-tailoring figures to correspond to the text, we have thoroughly reviewed the original art program for accuracy, use of color,

labeling, legends, and placement. Most of the original illustrations have been retained, many have been revised, and several have been completely reworked to increase sophistication and to reflect new information.

Multimedia-Supported Illustrations

Throughout the text the reader will find illustrations of microbiological concepts and processes that can be supplemented with full-color video, animations, or interactive screens from the new second edition of *Microbes in Motion* (0-072-29262-8), an interactive CD-ROM available from WCB/McGraw-Hill. The reader will be able to easily recognize these figures, because the relevant figure legends are preceded by a CD icon. Figure 25.12, reproduced here, is one example of such an illustration.

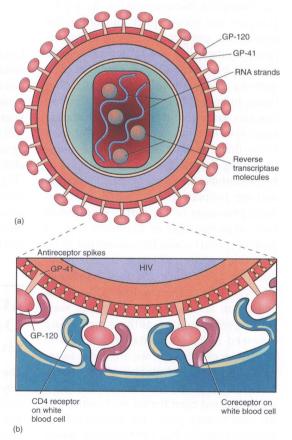


Figure 25.12

(a) A cutaway model of HIV. The envelope contains two types of glycoprotein (GP) spikes, two identical RNA strands, and several molecules of reverse transcriptase encased in a protein coating. (b) The snug attachment of HIV glycoprotein antireceptors (GP-41 and 120) to their specific receptors on a human cell membrane. These receptors are CD4 and a coreceptor called CCR-5 (fusin) that permit docking with the host cell and fusion with the cell membrane.

Correlation Guide to Microbes in Motion

Finding the corresponding information on the *Microbes in Motion* CD-ROM for the multimedia-supported illustrations just described requires a correlation guide, which is available to instructors. The *Microbes in Motion* CD-ROM is organized into 17 topical "books"; the books are divided up into "chapters," and the chapters have numbered "pages." For each multimedia-supported illustration, the correlation guide directs the reader to the book, chapter, and page on the CD-ROM where corresponding material can be found. The correlation guide entry is shown here for multimedia-supported illustration.

Microfiles

Every chapter contains separate boxed-off features called Microfiles. Some of them contain essential information that requires special emphasis; others provide enrichment details on newsworthy, practical, or historical topics that are related to the main text. Your instructor may assign these to you as additional reading. The Microfiles are denoted by icons in the following categories:



History



Biotechnology



Genetics



Medical Applications



Immunology



Spotlight



General Topics

Tables and Charts

The text contains about 125 tables and charts. Tables contain data, illustrations, or both, and are used to summarize additional reference and support information. Some figures contain lists of characteristics highlighted by bullets. Flowcharts, also called separation outlines, serve to overview, compare and contrast, and show relationships between various topics.

Chapter Checkpoints

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 can be to pause and review some important points before continuing on to the next topic. We have included in each chapter three to six brief summaries called Chapter Checkpoints that concisely state the most important ideas under a major heading and provide the reader with a quick recap of what has been covered to that point. Many instructors assign these as a guide for study and review.

Vocabulary

The study of microbiology will immerse the student in a rich new language. No one expects the beginner to learn all the new terms, but some ability to understand, speak, and write this new language will certainly be essential. To assist you in building vocabulary, we have highlighted principal terms in boldface or italics and have defined them at their first appearance



Chapter Checkpoints

Magnification, resolving power, lens quality, and illumination source all influence the clarity of specimens viewed through the optical microscope.

The maximum resolving power of the optical microscope is 200 nm, or 0.2 μm. This is sufficient to see the internal structures of eucaryotes and the morphology of most bacteria.

There are five types of optical microscopes. Four types use visible light for illumination: bright-field, dark-field, phase-contrast, and interference microscopes. The fifth type, the fluorescence microscope, uses UV light for illumination, but it has the same resolving power as the other optical microscopes.

Electron microscopes (EM) use electrons, not light waves, as an illumination

source to provide high magnification (5,000×-1,000,000×) and high resolution (0.5 nm). Electron microscopes can visualize cell ultrastructure (TEM) and three-dimensional images of cell and virus surface features (SEM).

Specimens viewed through optical microscopes can be either alive or dead, depending on the type of specimen preparation, but all EM specimens are dead because they must be treated with metals for effective viewing.

Stains are important diagnostic tools in microbiology because they can be designed to differentiate cell shape, structure, and biochemical composition of the specimens being viewed.

in the text. Terms marked by an asterisk or by a numbered footnote also have pronunciation and word origins given. As a rule, speaking a word will help you to spell it and learn its meaning. Because many scientific terms are derived from Latin and Greek, a grounding in these word roots will help you understand the meanings of other related words. A guide to phonetic pronunciation with examples as used in this text follows:

Chapter Capsules with Key Terms

The major content of each chapter is condensed into short summaries, called Chapter Capsules, in the form of a free-flowing outline. Key terms are placed in the outline to keep them in context with their associated topics. Capsules can be used as both a quick review and an overview of the chapter.

GENERAL GUIDE TO PRONUNCIATION AS USED IN THE TEXTBOOK

Letter	Pronounced	As In	Example in Text
A	ah	fat	bacteria (1st a)
	ay	day	lipase
	uh	along	schistosoma, bacteria (2nd a)
AE	ee	na des	archaebacteria, salmonellae
C	see	cease	cellulase
С	kay	cat	anaerobic, procaryote
СС	kay, then see		vaccine, cocci
Ch	kay	chorus	chemotherapy, spirochete
	ch	chest	chickenpox
	sh	chevrolet	chancre
E	ee	discrete	nucleus, gangrene
	eh	bet	cestode, mesosome
Er	ur	finger	thermophile
Eu	00	leukemia	Pseudomonas, pneumonia
	yoo		eubacteria
G	i	geologic	appendage
	guh	growth	glycolysis
I	eye	bite	halophile, spirochete, lipase
	ih	bit	facultative, aerobic
	ee	nutrient	Mycobacterium
0	aw	body	optical
numero ma	oh	cold	saprotroph
OY	oh-ee	oil	ameboid
oe	ee	VII	Entamoeba
00	00	mood	zoonosis
ox	ocks	pox	toxemia
Ph	eff	phase	staphylococci
Ps	sick	Psalm	Pseudomonas
S	ess	sense	spirochete
S	zee	pleasure	Blastomyces, plasmid
tion	shun	mention	sporulation
ture	chur	furniture	denature
U	yoo	uniform	
	uh		papule
UR	yur	cup	coccus purine
Y	yuı	why	
•	ee		mycosis
	ih	wary	Chlorodialas
	111	synthetic	Chlamydiales

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 to allow your instructor to assign questions for desired focus and emphasis. Questions with several parts are differentiated by letters so that all or part of a question may be selected. Because of space constraints, this book contains answers only to multiple-choice questions (in Appendix E). A guide for answers to all other questions is available to instructors.

Multiple-Choice (MC) Questions

This 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. These questions are compiled randomly from selected vocabulary and factual information. It is assumed that if you answer these accurately, you have a good understanding of other information in the chapter. In general, MC questions have only one correct answer, and this answer may be surmised by a process of eliminating the incorrect answers and narrowing the choices down to one.

Matching Questions Many chapters contain questions that list words and related descriptions. In single-matching questions, only one description matches a given word; in multiple-matching questions, several can match and you should choose all possible descriptions that fit the words in the list.

Concept Questions Education in a subject is not really complete until you can demonstrate understanding by writing in depth about the subject. The concept questions guide your review of the chapter by asking you to compose complete answers that cover essential ideas and correct terminology. This form of expression will require determining what is most important and rewriting it in your own words in concise, logical terms. Writing is an excellent way to learn vocabulary and usage, and working with the concepts will also help you commit them to memory. All information and terminology to answer these questions can be found in the main body of the chapter and in figures, tables, and Microfile readings. Most of these questions will require several sentences or paragraphs to answer fully.

Critical-Thinking Questions

Thought questions challenge you to use scientific thinking, analysis, and problem solving. They assume a substantial grasp of factual information from the chapter in which they appear and earlier chapters, and they require you to reason, find relationships, suggest plausible explanations, and apply concepts to real-world situations. Questions may involve case studies, research findings, and everyday household settings. Some assign demonstrations, models, or ideas for class discussion; some even call for an opinion. By their nature, most of these questions allow more than one interpretation and do not have a predetermined "correct" answer.

Internet Search Topics

One of the most significant and far-reaching sources of information in a rapidly advancing science such as microbiology is the Internet. There are thousands of Web sites covering millions of topics related to this subject. Rather than suggest specific Web sites, we prefer to direct your searches using a search engine such as Yahoo, Webcrawler, or AltaVista. Using a search engine will help you become acquainted with the wide array of coverage available, and you will not encounter inactive Web sites and dead ends. Most chapters suggest one or two topics or terminology to search, but nearly any subject or concept in the book can be accessed by simple word search. We strongly encourage you to use this fantastic and exciting resource!

Appendices

The appendices in this edition cover the following topics:

- Appendix A: Greek letters and units and prefixes of measurement (new)
- Appendix B: exponents and logarithms
- Appendix C: methods for testing sterilization and disinfection
- Appendix D: universal blood and body-fluid precautions and biosafety levels

- Appendix E: answers to multiple-choice questions
- Appendix F: a cross-reference for the major bacterial, fungal, parasitic, and viral agents and diseases, by system affected and mode of transmission

Glossary and Index

The glossary includes about 675 entries that define most of the boldfaced and italicized terms used in the text. Do not overlook the value of the index, which is extensive enough to include the vast majority of major and minor terms used in the text and can be an excellent tool for finding information.

Endpapers

The inside covers of the book depict printouts from the Centers for Disease Control and Prevention on the latest summary data for major reportable infectious diseases in the United States, listed by state and region. Summary data from 1998 were not available at press time, so these data from 1997 are the most recent information available. The back endpapers (hardcover edition only) present a summary table of disease incidence in the United States from 1989 to 1996 and other statistics on diseases such as AIDS.

Study Tips for the Beginning Microbiology Student

Most of you are taking this course in preparation for a career in allied health or some area of the biological sciences. You will probably already have had some experience in studying science. By their nature of being information-intensive, these courses require a significant input of time. They involve a certain amount of pure memorization, of, at the very least, terminology, and they require consistent study habits. The rewards for your commitment will be the gifts of knowledge and awareness that are crucial to your careers and lives. No one will ever be able to take those gifts away from you, and you will probably use them in some way every single day.

Teachers know that for many students the bottom line is their grade, but there are simply no shortcuts to a good grade. It is one of life's little truths that the more time you spend in serious study, the more you will learn, and an improvement in your grade will automatically follow. Just make sure the time you spend is used to maximum benefit. Many students highlight key portions in a chapter as they read, but such passive activity may exercise your hand more than your mind, and it can use up valuable time and energy.

You will retain far more information if you engage your mind in active thought about the words and ideas. Write marginal notes to yourself; question yourself on understanding; and highlight and reread only the most significant points. To add some fun to the process and speed it along, try making up mnemonic devices: little slogans that help you recall a series of ideas. One of our students developed mental pictures that helped her visualize processes. For example, she thought of DNA as the king in a castle, sending out messengers to do his bidding, or the TCA cycle as a weird Ferris wheel that takes on passengers at the top and lets them off at the bottom.

Another active learning process is to write questions and answers on index cards to quiz yourself periodically. Repetition is the secret to recalling information. 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. Biologists studying brain chemistry have recently determined the reason for that oft-repeated warning "Do not cram because it doesn't work!" It turns out that a certain receptor in the part of the brain that regulates memory must be regenerated about every 30 minutes. Any studying done when the receptors are exhausted will not be placed into memory. This means that you really should study in short bursts with frequent breaks. Even if you have to study over a longer stretch, try to relax for a few moments, take a walk, or involve yourself in something that does not require intense thought. Other worthwhile endeavors include studying with other students or a tutor in small groups, working with the study guide or CD-ROM, and surfing the Internet to find Web sites that have study guides or sample exams. And

don't forget to ask your instructor or teaching assistant for help if you are having a difficult time. They have a serious interest in your learning and success.

The subject matter in this text is fundamental, but it is not merely a review of information you have had before. Even if you have already completed a biology and chemistry course, much of the material it contains will be new to you. 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, because he or she knows what is most important for your course.

Supplemental Materials for Students and Instructors

LEARNING AIDS FOR STUDENTS

A Student Study Guide

Prepared by Jackie Butler of Grayson County Community College, the study guide contains study objectives, activities, and test-taking strategies, and a newly expanded section of questions. Answers to the objective questions are included.

A Multimedia Tie-in to Foundations in Microbiology

An interactive CD-ROM, *Microbes in Motion II*, was developed especially with this textbook. It contains full-colored animations and video programs to supplement the illustration program. Figures that are tied to the CD-ROM program are indicated by a small disc icon. This new version is Mac and Windows compatible.

Web Site

The publisher is launching a Web site for this text with links to more than 100 related microbiology sites. You can find it at http://www.mhhe.com.

TEACHING SUPPLEMENTS

Instructor's Manual with Test Item File

Developed by Louis Giacinti, Milwaukee Area Technical College, the instructor's manual is available as both a softbound manual and a computer diskette and contains an extended lecture outline with the complete headings of each chapter down to the fourth-level heads and Microfiles. Instructors can use this to organize their coverage and lectures. It also has a test item file of true/false, multiple-choice, matching, and short-answer questions to be used in compiling exams. A key to all questions is included.

Overhead Transparencies

A set of 200 color transparencies of the most requested figures are offered to all instructors who adopt the text. A Visual Resource Library CD-ROM with key words contains these images plus 200 more. This valuable product can be used for developing lectures and power point presentations.

Microtest Service

A computerized test file containing about 1,000 questions is available to all adopters. The program is compatible with Macintosh and Windows systems.

Acknowledgments

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