

CONTENTS

Preface	XIII
The Student Experience	XIX
Teaching Tools	XXII
Acknowledgments	XXVI
About the Author	XXVII
To the Student—Study Smart	XXIX

PART I Foundations of Microbiology 1

Chapter 1: Microbiology: Then and Now	2
1.1 The Discovery of Microbes Leads to Questioning Their Origins	6
1.2 Disease Transmission Can Be Prevented	11
1.3 The Classical Golden Age of Microbiology Reveals the Germ	16
1.4 With the Discovery of Other Microbes, the Microbial World Expands	21
1.5 The Second Golden Age of Microbiology Involves the Birth of Molecular Biology and Chemotherapy	24
1.6 A Third Golden Age of Microbiology Is Now	27
Chapter Review	31

Chapter 2: The Chemical Building Blocks of Life	35
2.1 Organisms Are Composed of Atoms	36
2.2 Chemical Bonds Form Between Reactive Atoms	39
2.3 All Living Organisms Depend on Water	44
2.4 Living Organisms Are Composed of Four Types of Organic Compounds	47
Chapter Review	62

Chapter 3: Concepts and Tools for Studying Microorganisms	66
3.1 Prokaryotes Are Not Simple, Primitive Organisms	67
3.2 Classifying Microorganisms Reveals Relationships Between Organisms	76
3.3 Microscopy Is Used to Visualize the Structure of Cells	85
Chapter Review	97

Chapter 4: Structure and Organization of Prokaryotic Cells	101
4.1 Prokaryotes Can Be Distinguished by Their Cell Shape and Arrangements	103
4.2 Bacterial and Archaeal Cells Have an Organized Structure	105
4.3 Cell-Surface Structures Interact with the Environment	107
4.4 Most Prokaryotic Cells Have a Cell Envelope	116
4.5 The Cell Cytoplasm Is Packed with Internal Structures	123
4.6 There Is Tremendous Diversity Among the Domains Bacteria and Archaea	128
Chapter Review	133

Chapter 5: Microbial Growth and Nutrition	137
5.1 Microbial Reproduction and Growth Are Part of the Cell Cycle	139
5.2 Optimal Growth Is Dependent on Several Physical and Chemical Factors	149
5.3 Culture Media Are Used to Grow Microbes and Measure Their Growth	156
Chapter Review	166

Chapter 6: Microbial Metabolism	169
6.1 Enzymes and Energy Drive Cellular Metabolism	170
6.2 Glucose Catabolism Generates Cellular Energy	177
6.3 There Are Other Pathways to ATP Production	185
6.4 Photosynthesis Converts Light Energy to Chemical Energy	191
6.5 Microbes Exhibit Metabolic Diversity	194
Chapter Review	197

PART II The Genetics of Microorganisms 201

Chapter 7: Microbial Genetics	202
7.1 The Hereditary Molecule in All Organisms Is DNA	204
7.2 DNA Replication Is Part of the Cell Cycle	211

7.3	Gene Expression Produces RNA and Protein for Cell Function	213
7.4	Mutations Are Heritable Changes in a Cell's DNA	223
7.5	Techniques Exist for Identifying Mutants	232
	Chapter Review	235

Chapter 8: Gene Transfer, Genetic Engineering, and Genomics 239

8.1	Bacterial Cells Can Recombine Genes in Several Ways	240
8.2	Genetic Engineering Involves the Deliberate Transfer of Genes Between Organisms	249
8.3	Microbial Genomics Studies Genes and Genomes at the Single-Cell to Community Levels	261
	Chapter Review	270

PART III The Control of Microorganisms 275

Chapter 9: Control of Microorganisms: Physical Methods and Chemical Agents . . . 276

9.1	Microbial Growth Can Be Controlled in Several Ways	277
9.2	There Are Various Physical Methods to Control Microbial Growth	279
9.3	Chemical Control Usually Involves Disinfection	291
9.4	A Variety of Chemical Agents Can Control Microbial Growth	296
	Chapter Review	306

Chapter 10: Control of Microorganisms: Antimicrobial Drugs and Superbugs 310

10.1	Antimicrobial Agents Are Chemical Substances Used to Treat Infectious Disease	311
10.2	Synthetic Antibacterial Agents Primarily Inhibit DNA Synthesis and Cell Wall Formation	316
10.3	Beta-Lactam Antibiotics Target Bacterial Cell Wall Synthesis	318
10.4	Other Antibiotics Target Some Aspect of Metabolism	321
10.5	Other Antimicrobial Drugs Target Viruses, Fungi, and Parasites	328
10.6	Antimicrobial Drug Resistance Is a Growing Challenge	332
	Chapter Review	346

Part IV Bacterial Diseases of Humans 351

Chapter 11: Airborne Bacterial Diseases . . . 352

11.1	The Respiratory System and a Resident Microbiome Normally Impede Bacterial Colonization	354
11.2	Several Bacterial Diseases Affect the Upper Respiratory Tract	359
11.3	Many Bacterial Diseases of the Lower Respiratory Tract Can Be Life Threatening	367
	Chapter Review	386

Chapter 12: Foodborne and Waterborne Bacterial Diseases 389

12.1	The Digestive System Has Diverse Resident Microbiomes	390
12.2	Bacterial Diseases of the Oral Cavity Can Affect One's Overall Health	396
12.3	Bacterial Diseases of the GI Tract Are Usually Spread Through Food and Water	401
12.4	Some Bacterial Diseases Are the Result of Foodborne Intoxications	403
12.5	GI Infections Can Be Caused by Several Bacterial Pathogens	406
	Chapter Review	423

Chapter 13: Soilborne and Arthropod-Borne Bacterial Diseases 427

13.1	Several Soilborne Bacterial Diseases Develop from Endospores	429
13.2	Some Bacterial Diseases Can Be Transmitted by Arthropods	435
13.3	Rickettsial and Ehrlichial Diseases Are Spread by Arthropods	443
	Chapter Review	448

Chapter 14: Sexually Transmitted and Contact Transmitted Bacterial Diseases . . . 452

14.1	Portions of the Female and Male Reproductive Systems Contain a Resident Microbiome	454
14.2	Many Sexually Transmitted Infections Are Caused by Bacteria	457
14.3	Urinary Tract Infections Are the Second Most Common Body Infection	465
14.4	Contact Diseases Can Be Caused by Resident Bacterial Species	470

14.5	Contact Diseases Also Can Be Caused by Bacterial Species That Originate Externally	476
14.6	Several Contact Diseases Affect the Eye ...	484
	Chapter Review	488

PART V Viruses and Eukaryotic Microorganisms 493

Chapter 15: The Viruses and Virus-Like Agents 494

15.1	Filterable Infectious Agents Cause Disease	495
15.2	Viruses Have a Simple Structural Organization	498
15.3	Viruses Can Be Classified by Their Genome	504
15.4	Virus Replication Follows a Set of Common Steps	508
15.5	Viruses and Their Infections Can Be Detected in Various Ways	517
15.6	Some Viruses Are Associated with Human Tumors and Cancers	519
15.7	Emerging Viruses Arise from Genetic Recombination and Mutation	523
15.8	Prions Are Infectious, Virus-Like Agents ...	526
	Chapter Review	529

Chapter 16: Viral Infections of the Respiratory Tract and Skin 532

16.1	Viruses Account for Many Upper Respiratory Tract Infections	534
16.2	Viral Infections of the Lower Respiratory Tract Can Be Severe	537
16.3	Herpesviruses Cause Several Human Skin Diseases	548
16.4	Several Other Viral Diseases Affect the Skin	554
	Chapter Review	562

Chapter 17: Viral Infections of the Blood, Lymphatic, Gastrointestinal, and Nervous Systems 565

17.1	Viral Infections Can Affect the Blood and the Lymphatic Systems	566
17.2	Some Viral Diseases Cause Hemorrhagic Fevers	573

17.3	Viral Infections of the Gastrointestinal Tract Are Major Global Health Challenges ...	581
17.4	Viral Diseases of the Nervous System Can Be Deadly	585
	Chapter Review	594

Chapter 18: Eukaryotic Microorganisms: The Fungi 597

18.1	The Kingdom Fungi Includes the Molds and Yeasts	598
18.2	Fungal Growth and Reproduction Are Dependent on Spores	602
18.3	Fungi Have Evolved into a Variety of Forms	607
18.4	Some Fungi Can Invade the Skin	616
18.5	Several Fungal Pathogens Cause Lower Respiratory Tract Diseases	620
	Chapter Review	628

Chapter 19: Eukaryotic Microorganisms: The Parasites 632

19.1	Protists Exhibit Great Structural and Functional Diversity	633
19.2	Protistan Parasites Attack the Skin and the Digestive and Urinary Tracts	641
19.3	Many Protistan Diseases of the Blood and Nervous System Can Be Life Threatening ...	647
19.4	Parasitic Helminths Cause Substantial Morbidity Worldwide	655
	Chapter Review	667

PART VI Interactions and Impact of Microorganisms with Humans 673

Chapter 20: The Host-Microbe Relationship and Epidemiology 674

20.1	The Host and Microbe: An Intimate Relationship in Health and Disease	676
20.2	The Host and Microbe: Establishment of Infection and Disease	682
20.3	Epidemiology Is the Foundation of Public Health	692
	Chapter Review	710

Chapter 21: Resistance and the Immune System: Innate Immunity 713

- 21.1 The Immune System Is a Network of Cells and Molecules to Defend Against Foreign Substances 714
- 21.2 Surface Barriers Are Part of Innate Immunity. 719
- 21.3 Coordinated Cellular Defenses Respond to Pathogen Invasion. 723
- 21.4 Effector Molecules Damage Invading Pathogens 730
- Chapter Review** 737

Chapter 22: Resistance and the Immune System: Adaptive Immunity 740

- 22.1 The Adaptive Immune Response Targets a Specific Invading Pathogen 741
- 22.2 Humoral Immunity Is an Antibody Response to Pathogens in Body Fluids 746
- 22.3 Cell-Mediated Immunity Detects and Eliminates Intracellular Pathogens. 756
- Chapter Review** 766

Chapter 23: Immunization and Serology 769

- 23.1 Immunity to Disease Can Be Generated Naturally or Artificially 771
- 23.2 Serological Reactions Can Be Used to Diagnose Disease 786
- 23.3 Monoclonal Antibodies Are Used for Immunotherapy 799
- Chapter Review** 801

Chapter 24: Immune Disorders and AIDS 804

- 24.1 Type I Hypersensitivity Represents a Familiar Allergic Response. 805
- 24.2 Other Types of Hypersensitivities Represent Immediate or Delayed Reactions. 816
- 24.3 Autoimmune Disorders and Transplantation Are Immune Responses to "Self". 823
- 24.4 Immunodeficiency Disorders Can Be Inherited or Acquired. 827
- Chapter Review** 838

PART VII Environmental and Applied Microbiology 843

Chapters 25 and 26 are available online with access code.

Chapter 25: Applied and Industrial Microbiology 844

- 25.1 Food Spoilage Is Generally a Result of Microbial Contamination and Growth. 846
- 25.2 Food Preservation Inhibits the Growth of Foodborne Pathogens and Spoilage Microorganisms. 848
- 25.3 Many Foods Are the Product of Microbial Metabolism 857
- 25.4 Microorganisms Are Used in the Production of Many Industrial Products. 865
- Chapter Review** 871

Chapter 26: Environmental Microbiology 874

- 26.1 Water Pollution Includes Biological Changes Harmful to Water Quality 875
- 26.2 Proper Treatment of Water and Sewage Ensures Safe Drinking Water 881
- 26.3 Microbes Are Indispensable for Recycling Key Chemical Elements 889
- Chapter Review** 897

Appendix A Metric Measurement and Temperature Conversion Chart A-1

Appendix B CDC Summary of Notifiable Diseases in the United States 2014 B-1

Appendix C Pronouncing Organism Names C-1

Appendices D, E, and F are available online with access code.

Appendix D Answers to Self-Test Questions (Concept and Reasoning Check Answers; End-of-Chapter Question Answers; and Figure Question Answers) D-1

Appendix E Answers to Clinical Case, Investigating the Microbial World, and MicroInquiry Questions E-1

Appendix F Answers to Chapter Challenge Questions F-1

Glossary G-1

Index I-1